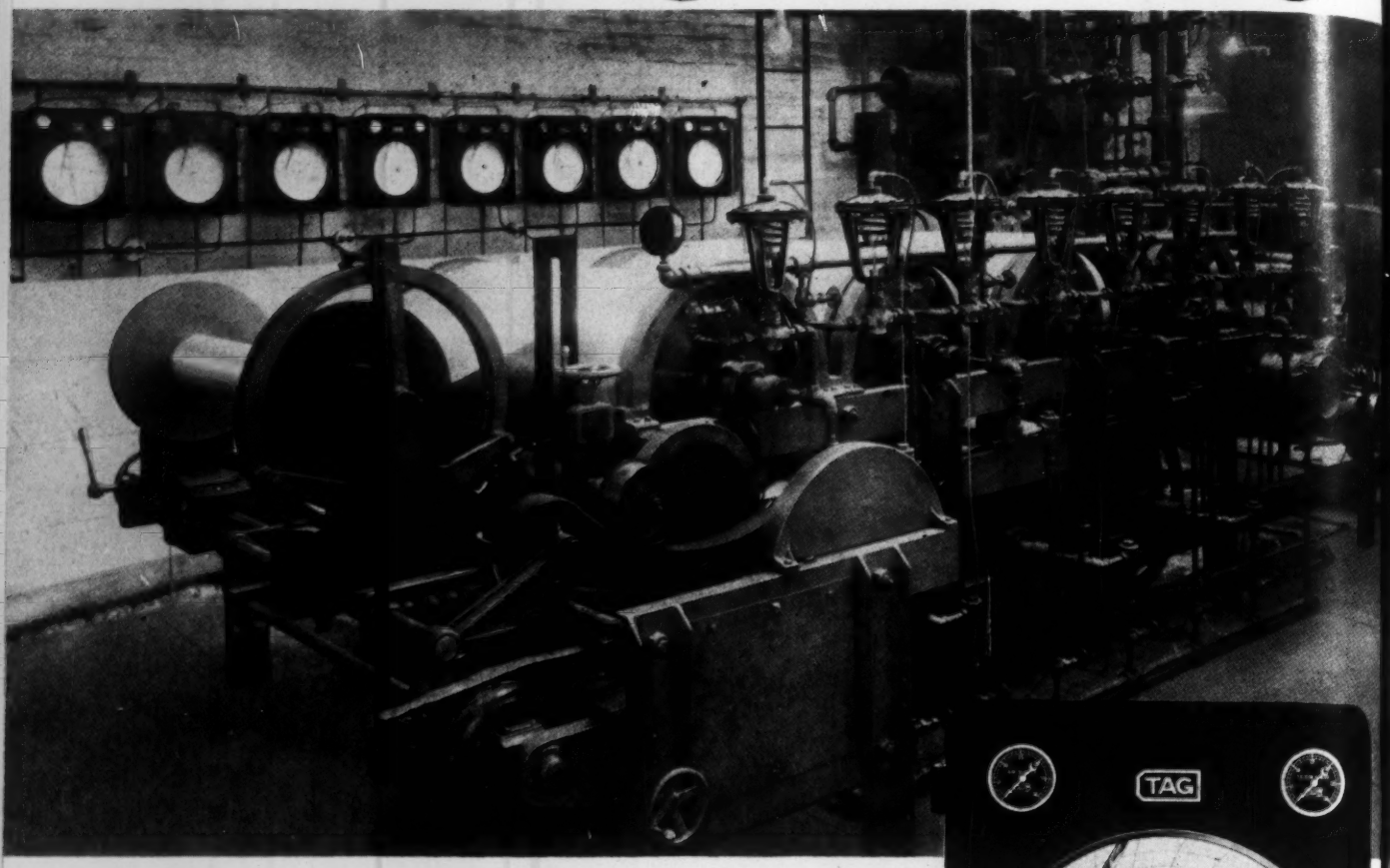
CT. 1947
.20 No. 10

Instruments

E MAGAZINE of MEASUREMENT and CONTROL

HEATING FOR *Strength* AND GREATER *Length*



TAG RECORDER—CONTROLLERS

Regulate Critical Process Temperatures

The TAG Recorder-Controller *automatically* regulates a series of related temperatures in this slasher installation of a large eastern textile mill. Thousands of long, tiny threads of rayon, celanese and silk are sized, then dried in exact accordance with a predetermined schedule. TAG control insures uniform treatment to every fiber of every thread so that it will reach the loom with maximum tensile strength, ready for the stress of weaving.

TAG Recorder-Controllers are accurate and dependable wherever the precise measurement and control of temperature and pressure are vital to quality of product. In *your* industry, whether it's Canning, Dairy, Plastics, Rubber, Petroleum, Chemical, Lumber or Textiles—

TAG Automatic Indicating and Recording Controllers are available in a wide variety of convenient ranges in three types: High Sensitivity (On-Off); Full Range Throttling; and Full Range Throttling with Automatic Re-set. Recording models with 9, 10 and 12-inch charts.

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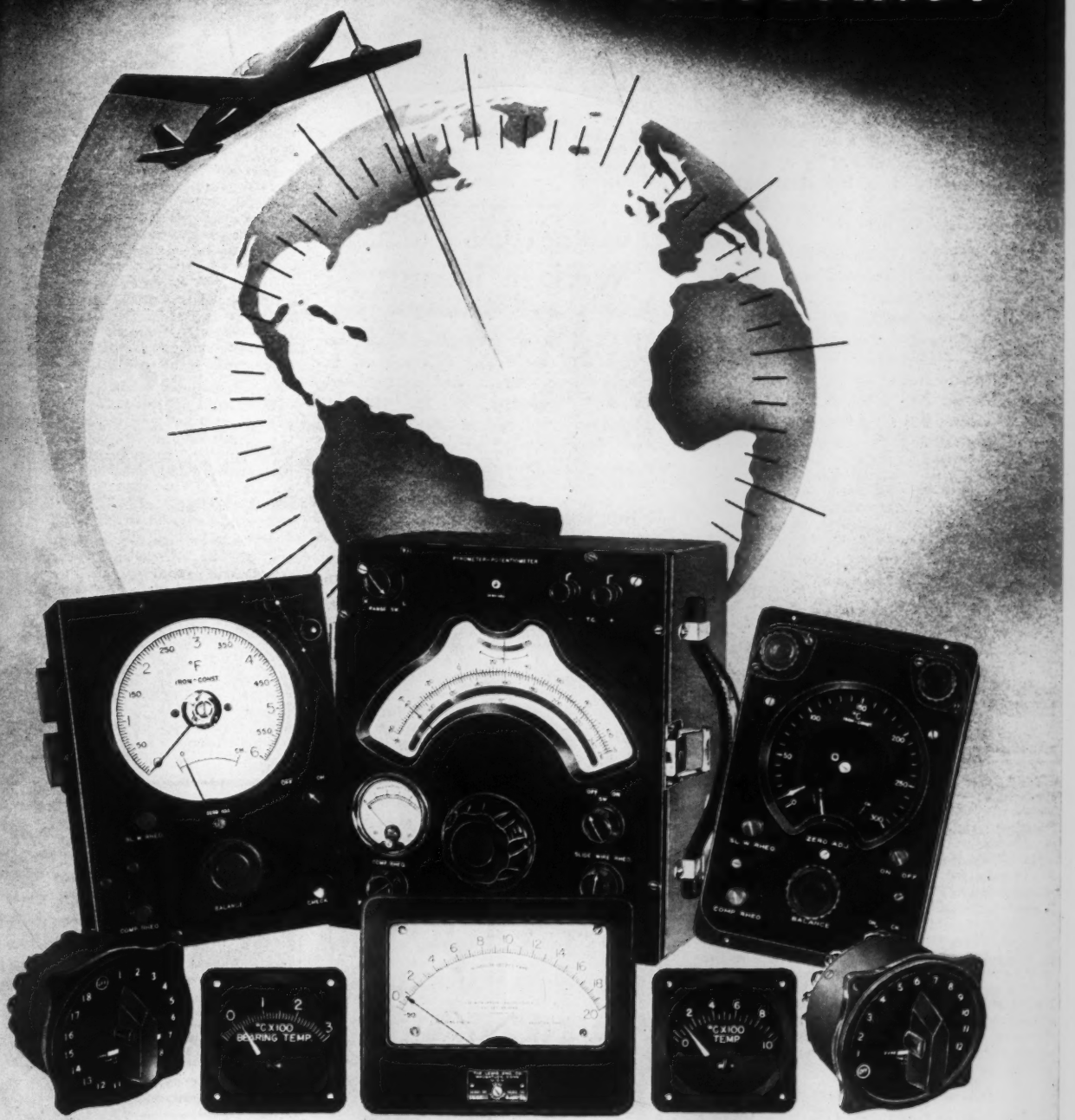

THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

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• PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

INSTRUMENTS ON THE MARCH

Penn State Instrumentation Course at Swathmore

[Received too late for September issue]

SWATHMORE, Penna.—The Pennsylvania State College Extension Service announces evening courses in Instrumentation beginning week of Sept. 22 at The Pennsylvania State College Center, 855 Harvard Ave., Swathmore.

Courses are sponsored by the Philadelphia Society for Instrumentation; are approved for both veterans and non-veterans.

ELEMENTARY INSTRUMENTATION

Course A—Pressure, Flow and Liquid Level (Physics 920X). 96 hours—Fee $45.00. 80 hours—Fee $37.50 (for students completing Physics 921X last semester). *Instructors:* Wm. A. Lindsay, Atlantic Refining Co., E. A. Adler and George H. Meiners. Instrument Dep't of Sun Oil Co., Marcus Hook.

1. *Pressure and Pressure Instruments:* Liquid, gas and vapor; Liquid column gages; Bell type gages; Bourdon gages.
2. *Liquid Flow and Flow Measurements:* Flow meters; Flow nozzles and orifice meters; Differential pressure measurements in flow meters; Liquid Level measurements.

Course B—Temperature and Electrical Measurements (Physics 921X). 96 hours—Fee $45.00. 80 hours—Fee $37.50 (for students completing Physics 920X last semester). *Instructors:* W. H. Furry and W. J. Kassimir, both with Instrument Department of Atlantic Refining Co., Philadelphia.

1. *Basic Theory of Temperature and Expansion.*
2. *Indicating and Recording Thermometers:* Bimetallic strips; Pressure actuated thermometers; Gas-filled thermometers; Vapor-pressure thermometers; Liquid-filled thermometers; Installation and testing problems.
3. *Electrical methods of Temperature Measurement:* Fundamentals of electrical measurement; Simple electrical circuits; Electrical measuring instruments; Thermoelectricity; Millivoltmeter measurements with thermocouples; Potentiometer measurements; Measurement of temperature by potentiometer; Resistance thermometer.

Prerequisites: High School graduation or Industrial Equivalent. Both courses are elementary. Instruction will be Lecture, Discussion and Demonstration. Demonstration equipment has been secured from manufacturers and others.

ADVANCED INSTRUMENTATION

Automatic Controls (Physics 922X). 96 hours — Fee: $45.00. *Instructors:* To be announced.

1. Review of Instruments used in measuring control variables.
2. Fundamentals of Automatic Control Theory and types.
3. Control Mechanisms.
4. Applications of Control Systems.

The early part of this course will be spent on the fundamentals of automatic controls. The latter part will include the applications with study and analysis of complete typical systems of instrumentation for control of various processes. The particular systems will be chosen to best fit the needs of the group who register.

Prerequisites: Physics 920X and 921X or High School graduation with a course in Mathematics and Science, and experience in Industrial Instrumentation.

Pittsburgh U's Graduate Work in Industry

[Received too late for September issue]

PITTSBURGH, Penna. — Numerous evening and Saturday courses on industrial measurement and control subjects are included in the 1946-47 "Graduate Work in Industry" program of the University of Pittsburgh in connection with the following companies:

Westinghouse Electric Corp., Aluminum Co. of America, Philadelphia Co. and Subsidiaries, Carnegie-Illinois Steel Corp., Gulf Research & Development Co., Jones & Laughlin Steel Corp.

Following is a selection (by no means complete) from the listings in the 48-page booklet issued by the University:

PROCESS ENGINEERING INSTRUMENTATION. Mr. Pelletere. A comprehensive course in the theory and application of basic instrumentation control in chemical processes. The instrument mechanism, pneumatic, hydraulic, and electrical, will be considered during the first semester. This will be followed by the applications of the various types of commercial units to industr practice. First and second sem- ters 3 credits each semester.

TIME STUDY.—Methods of making analyzing time and motion studies, including time study methods, operation analysis determination of standard times, construction of formulas, and developmen of wage payment plans. (For other than Industrial Engineering graduate students.) Alternating lecture and demonstration periods each week. Prerequisites: Mathematics 1 and 2. First semester only. Two credits.

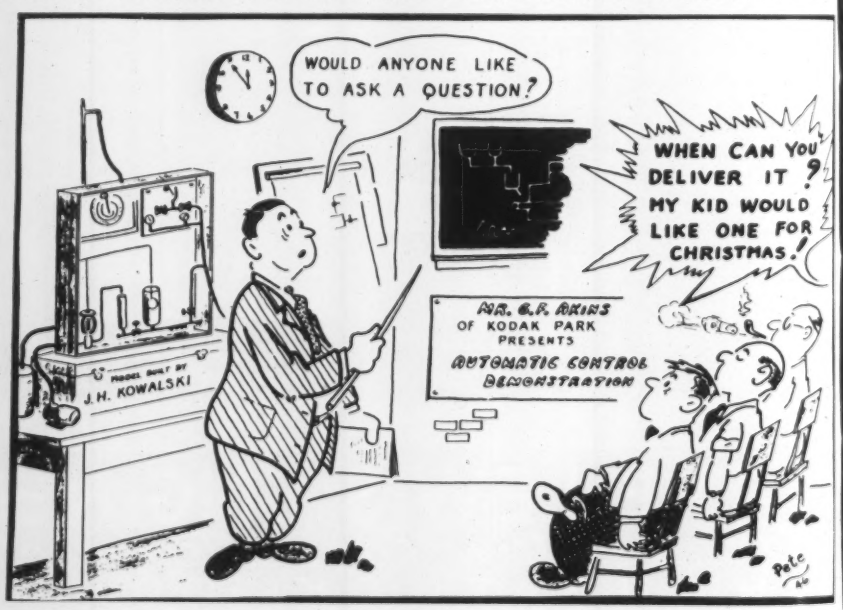
TREATMENT OF EXPERIMENTAL DATA. Dr. Worthing.—Representation of data by tables, graphs, and equations; graphical differentiation and integration; precision indices and their propagation; adjustment of conditioned measurements; least square equations; correlation; Fourier series; search for periodicities; mechanical and electric calculators. Prerequisite: Calculus. First and second semesters. Three credits each semester.

APPLIED SPECTROSCOPY. Dr. Warga. Spectrographic analysis of chemical, mineralogical, and/or biological samples. Lectures cover practical techniques used in qualitative and quantitative emission spectroscopy. Laboratory work: first semester qualitative techniques; second semester quantitative techniques. Some absorption spectroscopy, second semester. Prerequisites: First year courses in physics, chemistry, and mathematics; for graduate credit Physics 31 and calculus. First and second semesters. Four credits each semester.

X-RAY DIFFRACTION ANALYSIS. Dr. Sidhu —Operation of diffraction equipment; methods of making diffraction patterns and interpreting them; application to industrial problems in metallurgy, chemistry, and physics; crystal structure analysis of materials; results of x-ray analysis. Prerequisites: atomic physics and calculus. First semester only. Three credits.

FUNDAMENTALS OF INDUSTRIAL CONTROL. Mr. Markle.—This course presents a comprehensive study of the fundamentals of industrial control design. Consideration will be given to circuit design and control applications as applied to all types of motors in industrial service. First semester. Three credits.

SERVOMECHANISMS. Dr. Herwald. — This course will emphasize the principles of servomechanisms. Various error detectors, amplifiers and error correctors will be studied with particular regard to the characteristics that are important in servo


WOULD ANYONE LIKE TO ASK A QUESTION?
WHEN CAN YOU DELIVER IT ? MY KID WOULD LIKE ONE FOR CHRISTMAS!
MR. E.F. AKINS OF KODAK PARK PRESENTS AUTOMATIC CONTROL DEMONSTRATION
MODEL BUILT BY J.H. KOWALSKI
Pete

"Drawn by Perry Newman following Mr. Akins' demonstration before the Tennessee Section of the I.S.A." [*from letter transmitting drawing.*]

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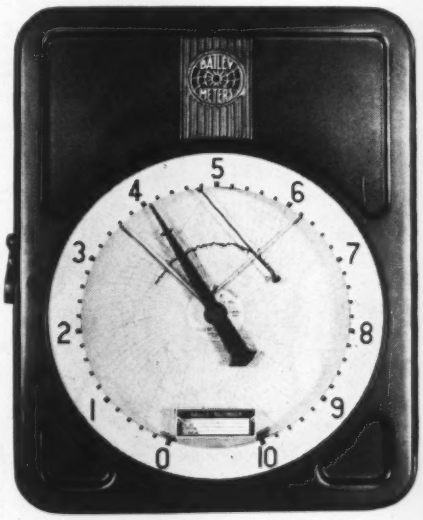
● This is a fact expressed in figures. It's a fact you can turn into money. Here's how:

The Bailey Meter Company has simplified electronic instruments and controls to 4 basic circuits and 8 basic component parts. With these 4 circuits and 8 parts you can get more than 100,000 combinations. It makes no difference what the application may be — temperature, flow, level, speed, gas analysis — you can do the job with standardized circuits and standardized parts — parts that are interchangeable.

But that's not all you gain with this instrument arithmetic. You save money on replacement parts. You don't need as many. You have fewer dollars frozen in the stockroom.



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You save on maintenance, too. Repairs take less time. Maintenance men quickly become familiar with Bailey standardized parts. Repairs are speeded up — lost production time reduced.

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P-15

Controls FOR THE PROCESS INDUSTRIES

Temperature • Pressure • Flow • % Oxygen • % Combustibles • Level • Density • Ratio

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RATOWEIR
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REFLUX-PRODUCT SPLITTING
ON DISTILLATION COLUMNS

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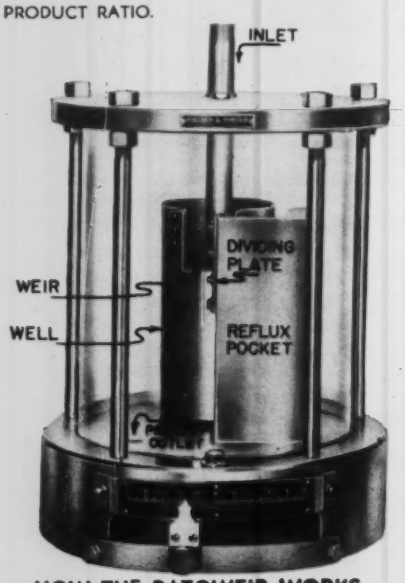
HAVE YOU BEEN INDIVIDUALLY DESIGNING AND CONSTRUCTING "RUBE GOLDBERGS" FOR SOLVING YOUR REFLUX ADJUSTING PROBLEMS ON DISTILLATION PROCESSES? IF SO, YOU CAN NOW ELIMINATE THIS COSTLY PROCEDURE AND USE F. & P. RATOWEIRS TO GIVE YOU ACCURATE AND INSTANTANEOUSLY ADJUSTABLE REFLUX-PRODUCT RATIO.



HOW THE RATOWEIR WORKS

The liquid from the condenser is discharged downward into a cylinder which is open at the top and which contains in one side a rectangular lip-type overflow weir. The cylinder is rotatably mounted so that the position of the weir can be varied respective to a vertically mounted knife-edge which divides the discharging fluid into two streams, one of which flows to the product outlet and the other, through a suitable containing pocket, back into the column.

For most applications RATOWEIRS are constructed with borosilicate glass housings and with manual lever type ratio adjusters. However, high pressure totally enclosed RATOWEIRS (sometimes with high pressure sight glasses) are also available. Electric or pneumatic motor drive with remote control for the ratio adjustment is also available. Catalog 90-B gives further information.

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DEPT. 7W-5C HATBORO, PA.

mechanisms. Simple "stabilizing" or "anti-hunt" means will be investigated and at least one complete servomechanism system will be designed. In this design the various methods available for calculating servo-mechanism performance will be discussed. Prerequisite: Differential Equations. Second semester. Two credits.

Time-study Lab at NYU

NEW YORK CITY.—A time-study laboratory, fitted with modern equipment to demonstrate the techniques of work simplification in the industrial plant as well as in offices, has been set up in the School of Commerce, Accounts and Finance of New York University, Professor William B. Cornell announced.

Closely resembling the average machine shop, the laboratory was built to enhance the value of a course entitled "Techniques of Time and Motion Study and Work Simplification," offered at the School of Commerce for the first time this Fall. In it, students will be able to conduct experiments in an atmosphere which will closely simulate the modern factory. Short films, illustrating actual time study and work simplification problems and their solutions in manufacturing concerns, will supplement the material offered in class.

New Physics Magazine

NEW YORK CITY.— David Katcher has been appointed editor of a new semi-popular monthly magazine on physics to be published early next year, it was announced by Dr. Herbert A. Barton of the American Institute of Physics, 57 East 55 Street, New York City.

The new magazine (not yet named) is planned to fill some of the gap which now exists between specialized technical journals and popular science magazines. The Institute already publishes eight scholarly journals and is the primary outlet for papers on fundamental physics research in the country.

"The magazine," Dr. Barton said in making the announcement, "can tap a rich field in fulfilling the double function of giving news on general developments in physics to the general public and news of professional activities to physicists."

When questioned about plans, Katcher explained that the magazine will not emphasize the spectacular. "We are faced with the choice of overdramatizing results, with the resultant loss of physicists as an audience and of general reader faith, he said, "or of keeping quiet until developments have proved

WHEN A FELLER NEEDS CONTROL BY Putt

YOUR PLAYFUL "HELPER" BLOWS SMOKE FROM A HUNK OF RUBBER TUBING THROUGH THE BACK OF THE PANEL JUST AS YOU CUT IN THE JUICE!
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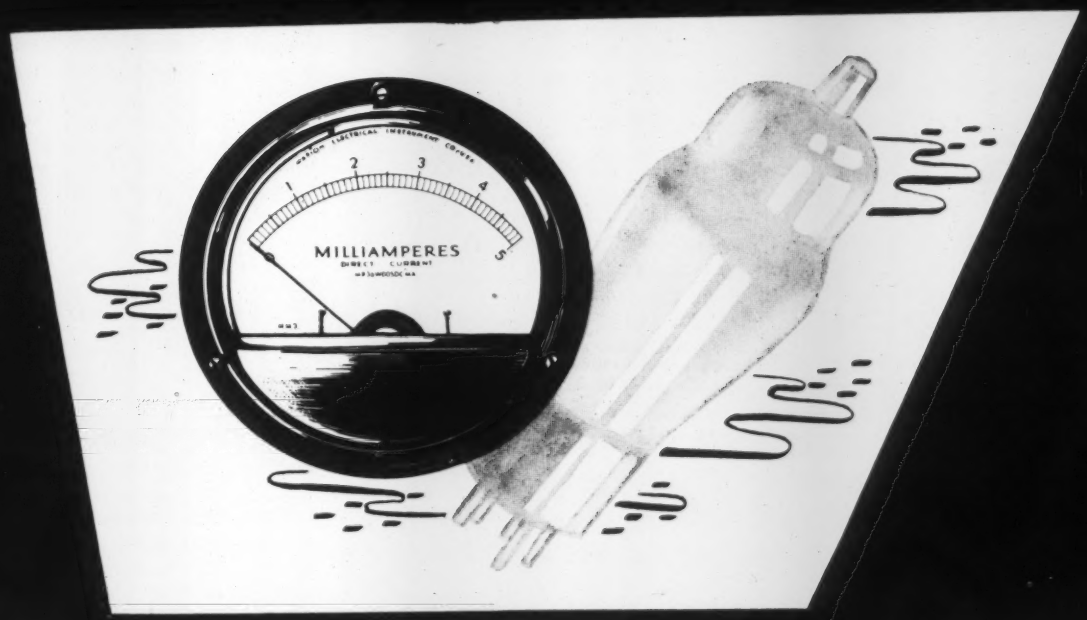

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Progressive manufacturers of electronic equipment declare an hermetic seal is as important in a meter as it is in any other product component. That's because meters are just as susceptible to the harmful effects of dust, moisture, corrosive fumes and other destructive factors as resistors, capacitors or transformers.

Therefore, hermetically sealed meters are a "must" in achieving top product performance.

MARION HERMETICS ARE NOT PREMIUM PRICED

Marion glass-to-metal hermetically sealed meters offer you the accuracy, superiority and extended life of an hermetically *sealed* component at a price no higher than most competitive *unsealed* instruments. All Marion hermetically sealed instruments are 100% GUARANTEED.

LOOK AT THE FEATURES OF MARION "HERMETICS"

DURABLE

. . . Unaffected by extremes of heat or cold . . . permanently protected against dust, dirt, moisture . . . instrument malfunctioning minimized.

SHIELDED

. . . Heavy steel case gives magnetic and electrostatic shielding so important in modern high frequency equipment.

INTER-CHANGEABLE

. . . The Marion case, with its high conductivity plating, eliminates the need for separate shielding and permits interchangeability on any type panel without affecting calibration.

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Interchangeable Round and Square Colored Flanges . . . one instrument can thus fill four different needs:

1. Round
2. Round for Steel Panel
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4. Rectangular for Steel Panel

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MARION ELECTRICAL INSTRUMENT COMPANY
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Unmounted Cells

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

In addition to the unmounted cells shown here, Bradley also offers cells in a variety of standard mountings, including plug-in and pigtail types.

For direct conversion of light into electric energy, specify Bradley's photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

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applicable, which hides the light of physics under a bushel, or of presenting a simple, pointed, non-technical account of developments whose inherent drama is not so much in speculation as it is in the conquest of knowledge itself. The last is the sense of what will be attempted and the hope is that in being useful to physicists at large the magazine will be useful to the general public as well."

National Electronics Conference to Feature Instrumentation

CHICAGO.—The program of the National Electronics Conference to be held at the Edgewater Beach Hotel, November 3, 4 and 5, includes two instrumentation sessions of five technical papers each. Of the seventy papers to be presented at other sessions, thirty have titles mentioning instruments or indicating that instrument subjects will be dealt with.

[Extracts from the official program follow:]

Monday, Nov. 3, 2:00 p. m. ELECTRONIC INSTRUMENTATION I

"Self Balancing Thermistor Bridge" by C. C. Bath and H. Goldberg, Bendix Radio Corp.

"Variable-ratio Inductance Bridges and Networks" by Paul Glass and Sylva May Dushkes, Askania Regulator Co.

"A Miniature Gastro-manometer for Electrical Recording" by H. C. Roberts, University of Illinois.

"Short-time Oscillography" by Jean V. Lebacqz, John Hopkins University.

"Luminescent Screens For Cathode-ray Oscillography" by Carl Feldt, A. B. DuMont Labs., Inc.

Wednesday, Nov. 5, 2:00 p. m. ELECTRONIC INSTRUMENTATION II

"High-resolving-power Infrared Recording Spectrometer" by R. C. Nelson and W. R. Wilson, Northwestern University.

"The Phase-meter" by E. O. Vandeven, General Electric Co.

"Accurate Measurement of Relative Phase" by R. Glaser, Massachusetts Institute of Technology.

"A Null Method for Determination of Impedance in the 100-400-Mc. Range" by J. F. Byrne, Airborne Instruments Lab., Inc.

"New Cathode-ray Oscillographs and Applications" by C. Berkley, A. B. DuMont Labs., Inc.

Among the subjects to be covered in other sessions are torquemeters, magnetometers, distortion measurements, impedance matching, UHF power meters, microwave spectrometry, mass spectrometry, computing instruments, servomechanisms, antenna pattern measurements, scintillation counters, telemetering systems, Teleran, various monitoring systems, etc.

Strobophotos Improve Engine Performance

NEW YORK CITY.—Ultra-high-speed photography using stroboscopic light makes possible the study of hitherto unknown fuel spray patterns of injection nozzles in internal combustion engines. The new injection nozzle test stand at the Beacon Research Laboratories of The Texas Company gives results which should produce greater efficiency of air and fuel utilization in engines.

The fuel spray photographs can be taken in one to two millionths of a second, so that the rapidly-moving fuel spray can in effect be "stopped" at any point and considerable detail is revealed concerning the general shape of the spray and the direction and distribution of the fuel particles. The stroboscopic light is synchronized with the fuel pump and the flashing circuit is arranged to permit either single or continuous shots. These shots show the spray pattern at any desired stage of its development from start to finish in this injection cycle.

EDITORIALS

By M. F. BEHAR

Plumbing Peddlers

YOU will see some of your best friends in the pictures on the next four pages. (These are all of the fifty-three photographs of last month's Instrument Show at Chicago that were made available to us.*) Some of the friends you will recognize are your fellow instrument users; others are instrument-company people. Once upon a time, you and your associates spoke of them as peddlers and of their products as plumbing—but not with a smile.

In those days, a cobalt curtain of conjectures, cross-purposes, clannishness, caprices, conceits and conflict kept you the buyers and them the sellers from knowing one another as human beings. In those days, there was not the meeting of minds which is essential for preparing specifications so unmistakably that the instrument will satisfy.

In those days, therefore, relatively few instruments were correctly specified and each side blamed the other: you claimed that all instruments in general and automatic controllers in particular were getting worse and worse; they claimed that their products had reached perfection. Most of them, being human, sincerely believed in the perfection of each new device they brought out. Many of the announcements they sent for publication in our New Instruments Department asserted that the new Model XYZ-987 was the most sensitive, the most rugged, the fastest in response, the most durable, the most powerful and—of course—the most accurate. They honestly resented our cutting out these superlatives which other technical journals printed, until they realized that *Instruments'* policy WAS different—as declared on this page in unmistakable language:

> Some trade paper publishers . . . sell their editorial pages . . . Pay them their thirty pieces and they will print anything you want, dressed up as "news."
>
> *Instruments'* news pages are not for sale. The New Instruments Department is not controlled by advertisers but is conducted solely for the information of our readers. Not one single item of legitimate news interest to our readers has ever been "killed." . . . This policy being exceptional, some manufacturers actually apologize for "troubling" a magazine in which they do not advertise. As if their appropriations could buy a single inch of our news space!
>
> In line with this policy, any matter received and deemed, after examination, of no value to our readers is consigned to the waste basket. Finally, since the news space is not for sale, we guard its high standard by wielding a blue pencil consecrated to the service of our readers. (Sept. 1932)

Yes, it was for your sake that we edited their announcements so severely. It was not for "their own good"—but it did turn out to be for their own good, because it helped remove a source of misunderstandings. And, while on the subject of removing misunderstandings, *Instruments* has never been TOO severe on the instrument manufacturers, as witness this other editorial which likewise bears repeating:

> " . . . Plant engineers therefore deserve credit—but in our opinion they deserve exactly one-half of the credit: the other half should go to the instrument makers who have . . . patiently studied the needs of their prospects and persistently carried on campaigns of education. This other fifty percent of the credit must therefore be meted out to all those who paved the way for the phenomenal purchases of industrial instruments which have been made and are still being made—to research and development men, to alert sales managers, to capable advertising managers, to technical journals that have promoted Instrumentation (no need of our being over-modest in this connection), to the higher executives, but above all to the men on the firing line—to the sales engineers of the instrument companies. It matters not how well the way was paved: these men had to fight nevertheless, and every order was the outcome of an intelligent engineering presentation, there are numerous instances of instrument sales engineers who for *years* had painstakingly surveyed the plants of their prospects (with the courteous assistance, of course, of the plant engineers) and who had thus largely paved their own way by being able to answer technical questions, display an intimate knowledge of the application, and present detailed figures of expectable results." (Apr. 1931)

It is as true today as it was many years ago that all those who invent, design, develop, build, sell, specify, buy, install and maintain measuring instruments, gages, meters, automatic controllers, automatic inspection devices, etc., are all brothers . . . making better things for more people, eliminating repetitive drudgery and making our world a better one.

Today you still call them peddlers and their products plumbing—but with friendship and respect. As a sign of this transition, the words plumbing and peddlers are printed without quotation marks in this editorial. —MFB

*There were fifty-four, but we left out the picture of The Instruments Publishing Company's booth.

The Back of the Board

TWENTY years ago, at a conference of industrial instrument company engineers, one daring speaker ridiculed complaints that the then-new centralized control boards gave trouble because of air pockets or liquid pockets in long connecting tubes, shorts and voltage drops in long electric lines, etc.

"First take a look at the back of the board," he advised: "If it is neat and orderly, the customer faithfully follows the small-type recommendations at the bottom of our instruction sheets; if it is a dirty jumble, the customer *won't* look for improperly-inclined tubing, improperly-connected cables, etc., because he *can't* look for them on account of the dust, dirt and disorder. Call this obstacle to his attention in a polite way and he probably will remove it by himself."

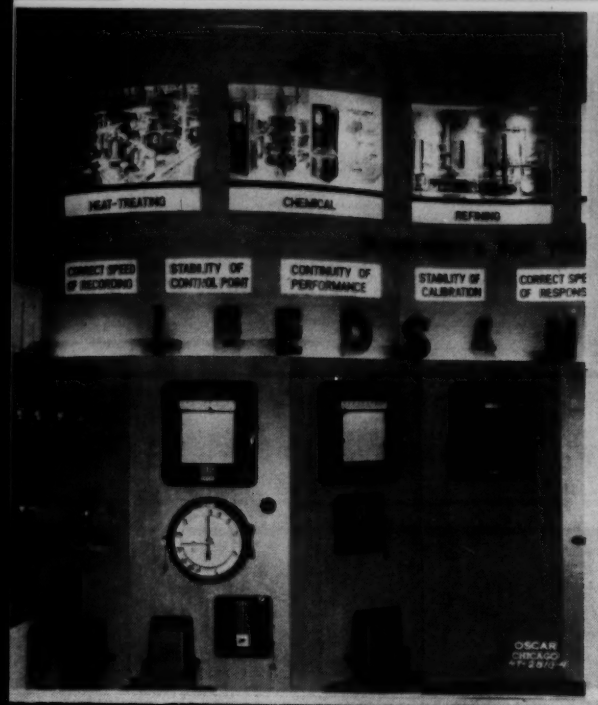
Outcome: an educational advertising campaign featuring "the back of the board." Result: gradual improvement of installation conditions.

Ten years ago, this same speaker was being escorted through the Rouge Plant Power house of the Ford Motor Company by Power Superintendent W. W. Dulmage. While walking down the aisle between the row of individual boiler panels and the row of boiler-fronts, the visitor stopped and asked Mr. Dulmage: "May I see the backs of these boiler panels?"

"You certainly may," said Mr. Dulmage, leading his guest to a . . . well, to a heaven! Each back-of-the-board space turned out to be a well-lighted, well-ventilated room. The fascinated visitor took out his breast-pocket handkerchief, rubbed it on the laid-composition floor and examined it: it was unsmudged!

Another ten-year period passes . . . now, not only are control boards housed in special buildings but the *roof* of the control house becomes the subject of meticulous attention to facilitate inspecting inch by inch the hundreds of connections between instruments and remote processing units. That is why we feature on this month's cover the roof of the control house of the butyl rubber plant operated by the Humble Oil Co. at Baytown, Texas. —MFB

Interior view of control house whose roof is shown on cover.


HEAT-TREATING
CHEMICAL
REFINING
CORRECT SPEED OF RECORDING
STABILITY OF CONTROL POINT
CONTINUITY OF PERFORMANCE
STABILITY OF CALIBRATION
CORRECT SPE OF RESPONS
LEEDS & N
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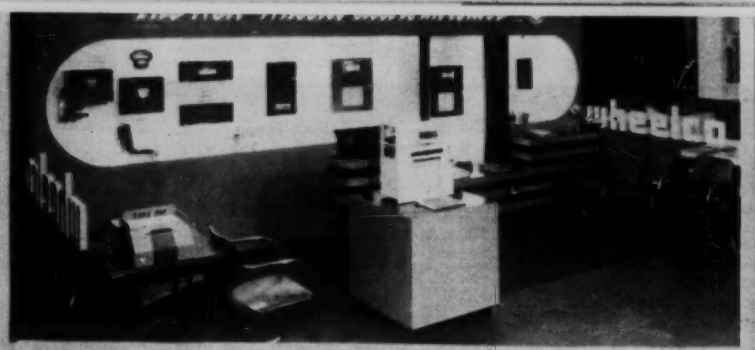

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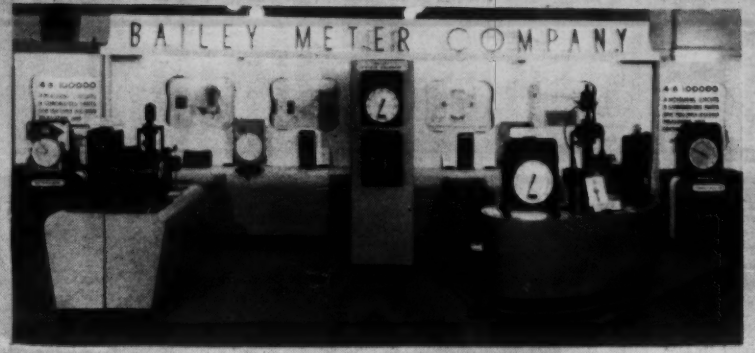
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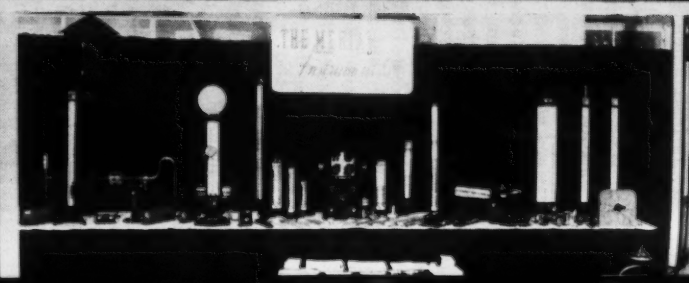

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Thwing Albert Instrument Co

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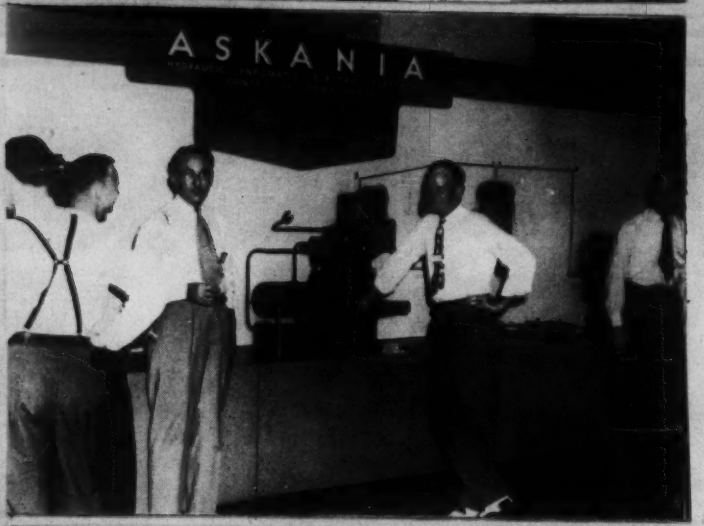
CARSON Electronic Micrometers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PERMUTIT ··· SIMPLEX
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FLOWRATOR
FLOW RATE INSTRUMENT
TRERICE
PALMER Thermometers INC

Functions and Responsibilities of a Plant Instrument Department*

By J. G. KERLEY, Manufacturing Engineering Dep't, Shell Oil Co., Inc., New York.

BEFORE proceeding with this dissertation, it might be well to clarify the title. By "functions" we mean the duties, trusts and other business belonging to, or required of, a profession. By "responsibilities" we mean all the obligations and liabilities involved in properly discharging those duties, trusts and other business.

One of the responsibilities of a profession is the competent execution of its functions. This means that the profession must assemble all the necessary talents, tools and other requisites for performing its duties. This engenders other responsibilities. For instance, education of personnel is not necessarily a function of an Instrument Department; but provision of properly educated and trained personnel most certainly is a responsibility of an Instrument Department. Therefore, under certain conditions, personnel education may become its responsibility. Briefly, functions breed responsibilities; responsibilities result from functions.

Even the term "Instrument Department" needs some definition; because there are just about as many different kinds of Instrument Departments as there are different types of plants. Usually the Instrument Department is a service organization that has evolved, or that just grew, to meet the needs of the particular plant it serves. Some consist of only one or two men whose principal duty is the maintenance of one type of instrument. Others are composed of a hundred or more men who service, along with conventional measuring and controlling apparatus, practically everything from the automatic operator on the plant gate to the working whistle.

It is necessary to draw a line somewhere between these extremes; so for purposes of discussion, we have constructed a hypothetical semi-modern chemical processing plant where units have been added gradually over the last fifteen years. In general, its processes are continuous, but a few batch-type units remain. It employs a little over 200 operating personnel supervised by a staff of some thirty persons, and employs a maintenance crew of about 125 men. Its warehousing, shipping and clerical staffs excluding Management total 150 employees. It represents an initial investment of some $15,000,000, about a third of which has been written off or retired. About 5% of this investment—roughly $4,000 per operating employee—was expended for measuring and controlling equipment.

The Instrument Department at this plant consists of 25 men, including the foreman and a department head who also acts as Instrument Engineer. About its duties it has some definite, fixed ideas. It insists that measurement and control is its business. It asserts emphatically that it should service not only the final indicating or recording means, but also all the other elements—that is, the primary element and connecting piping—that make up the measuring system. Likewise, it insists on maintaining all the elements of the controlling system including the measuring system, the controller mechanism, connecting tubing or wiring, and the controlled element, be it valve or other. It wants jurisdiction over all the measuring and controlling devices in the plant with the possible exception of a few pieces of specialized laboratory apparatus. It wants nothing more; it wants nothing less.

It does not want to maintain the telephone system, despite the fact that 'phones are sometimes called "instruments." Neither does it want to service the several loud-speaker and public-address systems in use in the plant. It has won a jurisdictional dispute with the Machinists and was awarded the servicing of control valves. It has lost a jurisdictional dispute over instrument piping to the Pipefitters, and a similar one over pyrometer lead-wire to the Electricians, with the express provision that the Instrument Department has the authority to condemn work not meeting its standards. It does not want, but is saddled with, a large number of "nuisance items" passed on to it simply because no other department could, or would, service them properly: vacuum educators and ejectors, refrigerators and water coolers, steam-jet hot water heaters, etc. It has under its care the various items manufactured by approximately forty firms. It is struggling along with an educational program, some nebulous policies, and mediocre coöperation.

Thus we have our Instrument Department. We think it is fairly typical. Its prototype, complete with organization, jurisdiction, attitudes and problems, exists in several plants with which we are familiar.

What are its functions? What responsibilities do they entail? Much has been written the last fifteen years in answer to these questions. Aside from some 130 magazine articles dealing directly with the duties, organization and problems of Instrument Departments there have been numerous sections of other articles and books devoted to these topics. In addition, this has been supported by numerous reports, summaries and recommendations issued for limited circulation only.

In general, as we stated in our definition, a function of the Instrument Department is some duty that is expected of it. This implies that functions are determined or established by some agency outside of the department. Often they accumulate by some other agency saying "Let's turn this over to the Instrument Department." This usually occurs where the Instrument Department just grows, and duties and assignments keep accumulating in a sort of hodge-podge that eventually must be straightened out. Occasionally, recognition comes directly from Management along with a clear-cut definition of duty, but this is rather rare. Usually, it is up to the Head of the Instrument Department to force the issue. Quite often he voluntarily defines his functions in establishing the character of his responsibilities.

Regardless of past attitudes, methods of growth, when or how determined, it usually is established that the Instrument Department has one all-inclusive function: "the assurance of maximum accuracy from all the measuring devices under its care, and of optimum control from all the automatic regulating mechanisms under its jurisdiction." This is the father of all its other functions and the origin of most of its responsibilities. Three major functions are its direct descendants: (1) the selection of the instrument, (2) the installation of the instrument, and (3) the maintenance of the instrument.

Accuracy of measurement and optimum control are dependent on these three things, none of which is more important than the others. Selection, installation and maintenance must be given proper attention if the primary function is to be discharged. Since the Instrument Department is responsible for accuracy and control quality, these three functions and all their attendant responsibilities should be placed in its hands. Let us briefly examine some of the responsibilities these functions carry with them.

Selection

The first thing to be determined in the selection of the instrument is its application. This requires a basic understanding of the process. The person making the selection must understand the duties required of the instrument so that he can determine its range, as

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well as its accuracy and sensitivity specifications. He must know the characteristics of the material with which it is to be used so that he may choose the proper materials and construction details. He must know its physical location so that he can select proper case design, explosion-resistant characteristics, etc. He must have some knowledge of operating details and be able to recognize job peculiarities that, particularly in automatic-control service, influence efficiency. He must know the characteristics of pumps, heat exchangers, columns, blowers and other equipment with which his mechanisms are to be used.

This constitutes a large order. It is tantamount to saying that each Instrument Department must incorporate a process-control engineer, but that is not necessarily true. If proper cöoperative policies are worked out, this function can be discharged rather easily and with very good results. This will be discussed in more detail later. Suffice to say for the present that the Instrument Department must have available all the knowledge and talents set forth above. It can then proceed with its other duties in making a proper selection; i.e., the type and grade of the instrument for a given application.

The choice of details such as the physical principle upon which measurement is based, design of primary element, principle and method of intelligence-transmission, etc., should be surrendered completely to the Instrument Department. They are just as much a part of the measuring system as the final measuring means. And most certainly the Instrument Department should specify the grade of the instrument; that is, the refinements, the number and character of its control functions, if it is a controller. Likewise, if it is a controller, the Instrument Department should select the principle to be utilized in control, be it electric, pneumatic or other; and should calculate the dimensions and specify details of the final controlled element and all its appurtenances.

This, too, sounds like a large order; but as the head of any Instrument Department knows, it is not at all difficult if the proper fact-finding organization has been set up within the Department. This involves other responsibilities, of course. A complete cost and performance-data file must be set up to guide selection aright in the matter of costs. Incidentally, we might make the observation here that first cost is relatively unimportant in the selection of an instrument. Ultimate costs are what count. If a higher-priced instrument requires less maintenance, will make more product, or better product, it is much less expensive in the end than a low-priced one. Experience, the Instrument Man's chief stock in trade, is essential in proper selection of instruments; but an ultimate cost file is very helpful if an argument arises with other departments over initial costs. It may be beneficial for the Instrument Department to set up and adhere to a standardization policy. This reduces parts stock — among its many other beneficial features—and it has a direct bearing on instrument selection.

The importance of proper instrument selection cannot be over-emphasized. If all the details that constitute a measuring and/or controlling system are not thoroughly investigated and provided for, the successful functioning of the instrument will be a matter of luck, and these important details are so numerous that the odds are 10 to 1, 50 to 1, or 100 to 1 against optimum operation. Doubtless all of us have seen head meters applied on the discharge of simplex reciprocating pumps and accurate measurement expected. Many of us have seen two-position pressure controllers applied to fractionating columns whose temperatures must be held in steady state. These two practices are for the most part ancient history now. Everybody knows better. Let's take something more modern.

In cascaded control systems for regulating liquid level, we quite often encounter a liquid-level controller whose air-output pneumatically sets the index on a rate-of-flow controller. As often as not, probably more often than not, one will find the liquid-level controller equipped only with proportional band adjustments, while the flow controller is equipped with elaborate mechanism for proportional speed floating action. This is exactly the opposite of what is required for optimum control. The level controller, the master in command of the process, whose response is influenced by inflow as well as outflow, by vessel shape and other factors, cries out in a loud voice for floating action (or "automatic reset" to use a condemned, but probably more widely recognized, term). Its slave, the flow controller, with practically zero dead time and a very short time constant, has only one duty—to obey the commands of the LLC. It needs only proportional position action and will probably respond best when set only slightly under ultimate sensitivity.

Only the Instrument Man knows these things. The process man can't keep in his head the tremendous volume of such details. Instrument selection is the right, the duty, and should be the recognized function of the Instrument Department. It carries with it one other important responsibility — keeping up with latest developments, but this will be discussed in more detail later.

Installation

Let us now examine the second of the major functions, that very important item, installation. Regardless of the quality, type, grade or initial cost of the instrument, it can never function properly unless it is properly installed. We have some instruments that would render a far greater service were they completely removed and stored in a warehouse. Owing to faulty installation they are purveyors of false information, more detrimental to the operator than to information. An instrument improperly installed is seldom accurate, always expensive to maintain, and is a general source of annoyance to everybody concerned. Further, its untrustworthiness affects the morale of the operator on the theory: "if you can't trust it, why worry about it?"

It is a paying proposition to correct faulty installations, but it is much more economical to prevent them. This can be done by placing supervision of all installation, whether local or by contractor, in the hands of the Instrument Department. We are in complete agreement with our typical Instrument Department. It should either do the work itself or have authority to condemn the work of others.

If the Instrument Department is assigned this duty, it must shoulder several responsibilities. In the first place, it must carefully compile a complete set of installation standards to be presented to the people doing the work. It must check the contractor's typical installation drawings to see that they conform to these standards. When piping, wiring and equipment prints are available, it must carefully check them for such items as improper length of orifice runs, faulty electrical hookups, improper location of pyrometer wells, etc. In short, it must do everything to correct faults before they emerge from the blueprint stage.

But not all the faults can be corrected in this stage. The contractor is handicapped when it comes to instrument installation. He must use whatever labor is available locally for his installation crews, and it is very seldom that he can find on the labor market anyone who understands even the rudimentary principles of instrumentation. As a result one may find a series 60 weld-neck orifice flange welded to a schedule 40 meter run without regard to the resulting "collar" that distorts the stream flow. "Double-reverses" are found in pyrometer circuits, pressure seal pots are found mounted upside-down, temperature recorder sockets are mounted in dead areas instead of the point of highest velocity. These things are really not the fault of the contractor and quite often are embarrassing to him when they are pointed out. We believe that he will usually welcome what it is the duty of the Instrument Department to provide: a competent instrument inspector. This man should have a complete knowledge of instrumentation, and should inquire of workmen before they do a job how they plan to do it and thus prevent their doing it wrong. This is better than eventual condemnation. A competent man using this method should be able to save considerable sums because correction of faulty installation is expensive. A recently-published figure for one company showed approximately 5,000 man-hours for correcting faults, breakage, etc., on one large plant. Doubtless this figure is small compared with losses that would have accrued had not the faults been corrected.

Maintenance

Now let us turn to the best-known and probably most widely recognized function: maintenance. It is about this function that most information has been published. Sixty-four articles on organization, training, duties, and so on have been published in *Instruments* alone since 1932. So many are the responsibilities that they are difficult even to enumerate. However, they are comparatively well-known and prolonged discussion is not justified. A brief classification should be sufficient.

In general, this function can be divided into four important duties:

The first is provision of proper departmental personnel. The attendant responsibilities are: compilation of adaptability tests and "entrance examinations"; education and training of mechanics; provision of suitable texts and maintenance instructions; establishment of satisfactory working conditions; and maintenance of departmental morale.

The second is the provision of suitable shop facilities, and the responsibilities are: provision of adequate space to work equipped with the best obtainable lighting and ventilating facilities (air conditioning where required); procurement of all necessary cleaning equipment, tools and labor-saving devices; procurement of adequate primary standards, calibrating and testing equipment; and provision of suitable and convenient space for the storage of tools, parts, and equipment in process of, or awaiting, repairs.

The third is departmental management, entailing such responsibilities as: distribution of personnel; dispatching the work; maintenance of safety; management of supplies; compilation of cost and data files; preparation of charts of lubricants, packings, diaphragm materials, etc.; compilation of a suitable library, and the many other details that constitute the efficient handling of the department.

The fourth, and one of the most important, is departmental coöperation. It necessitates establishment of and adherence to definite uniform policies with the other departments in the plant. Periodic meetings with the heads of these departments along with representatives from the technical section, the laboratories and management often prove quite fruitful. It is only at such meetings that instrument exchange policies, spare stock agreements, and uniform procedures can be worked out. Other benefits to be derived from such gatherings will be discussed later.

Hindsight and Foresight

These, we think, are the most important recognized functions and responsibilities of our typical Instrument Department. As stated before, they have been known, talked about and written about for years. This does not mean, however, that they have been accepted universally. In some plants the Instrument Department has no part whatever in selection, and very little part in installation. In others it is denied the right to service control valves. In still others, despite the fact that the Instrument Department is charged with accuracy of measurement, heads of other departments indiscriminately change the elevation of thermal systems and calculate and install new orifice plates without its knowledge.

Unhappy, indeed, must be the Supervisor of such a department, and uneasy must lie his head. His first, more imperative responsibility is to rectify these conditions. Despite the fact that his efforts may precipitate jurisdictional disputes and minor interdepartmental rows, we doubt that he will have much difficulty, if he carries his argument to Top Management. Management knows that if an Instrument Department is allowed to service only the mechanism in the instrument with all pipe work done exclusively by the Pipefitters and all control valves maintained by the Machinists, then the Instrument Department cannot be held responsible for control quality. It realizes that the agency actually responsible is the one to whom the heads of these three groups report. Management will doubtless endorse the Instrument Department's recommendations, and grant the authority necessary to rectify such conditions.

Such rectification may prove embarrassing, however, because despite the fact that it may be due to haphazard growth, in most departments this situation should have been cleared up years ago. Rectification now is based on "hindsight" rather than "foresight." Nevertheless, it should be done. Selection, installation and maintenance are all functions of the Instrument Department and, as our typical Instrument Department contends, complete authority over all measuring and controlling system elements should be granted to it. Otherwise, it cannot competently discharge its primary function.

We have said that corrections based on "hindsight" can be embarrassing. This emphasizes the importance of another type of responsibilities — those based on "foresight." These duties have their origin in a rather broad, blanketing function, never quite definite, sometimes not even recognized. Management, in most cases, expects its Instrument Department to "stay on its toes," to keep informed on latest developments, to project its thinking into the future, and organize its resources to meet future requirements. Be it nebulous and hazy, this is a function of considerable consequence; and of all its attendant responsibilities, there is one so imperative that we are inclined to issue it as a command: "Stay Young!"

In this audience we have quite a few Heads of Instrument Departments. Some of us have been in the game for ten, fifteen and twenty years. Some of us are getting a little gray now, though perhaps prematurely; and some of us are growing bald. But, regardless of the condition outside the skull, what's IN it must be amenable to new ideas, even if they are definitely of "long-hair" derivation. We may be getting a little heavy around the waistline, but we can tolerate no middle-aged fat between the ears. We are in the youngest, fastest-moving profession in existence. We must keep our thinking young, our attitudes aggressive, and our horizons wide. As individuals, we can do this by participating in programs like this one, by membership in technical societies, by serving on the committees that are gathering together some of the loose ends that were scattered helter-skelter by the rapid progress of our profession. Departmentally we can "stay young" by hiring young graduates who have exerted the extra effort to master courses in special measurements, process control, and servomechanisms which, incidentally, are seldom required for graduation. These youngsters may be labeled "long haired boys," but usually they are well-grounded in the arts of physical analysis and mathematical solution. Their ability, exuberance and aggressiveness, under the reins of experience, should prove highly beneficial to our departments.

The second responsibility is to analyze trends. "Trends" here do not refer to, let us say, the tendency to use rectangular-case instruments instead of round-case types. The trends we speak of refer to the significant movements of and improvements in measurement and control methods, and their influence on process design and operation. Analyzing them amounts to extra-polating the instrumentation progress curve, and before we can extrapolate we must examine the existing portion of our curve and determine the character of the practices of bygone years.

Predicting the Future

In any industry you choose to examine, process design and instrumentation have advanced together. Their progress has been not unlike that of two boys tied together for a three-legged race. Each takes an individual step, then they take a step together. That is exactly what has happened in the case of processes and instruments. A process would demand a certain instrument and somebody would build it. The builder would get a new idea, build a model and take it to the process designer, who might be able to use it to better his process. Their progress was somewhat jerky, and there were some spills, but they went places. Indeed, they are continuing to go places for, in general, this three-legged race is still going on. These two agencies have hobbled and hopped through three "instrumentation eras" and are now entering the fourth.

In the beginning of any industry, processes were crude. A minimum of basic equipment was used and operators were instructed to do things a certain way so the resulting product would meet specifications. A few pressure gages and mercury-in-glass thermom-

eters were used, and operators found by maintaining certain conditions with them, better product or higher yields could be obtained. This was, let us say, *the indicator era.*

Process design was making headway but chiefly in better equipment design. A new type pump was hailed as an innovation, but operation still depended on "doing certain things a certain way," or maintaining those "certain conditions." Operators began to suspect their subordinates were not maintaining those conditions and installed recorders as "tattle-tales." This was a new era in instrumentation that may be called *the recorder era.*

Although they continued to demand bigger and better machinery and vessels, process designers also began to apply thermodynamics and other fundamental laws of physics and chemistry to their reactions. And they found that, for optimum yield of highest quality product from a given raw material, these "standard conditions" must be maintained exactly and continuously. This is something that human beings cannot do for long without going raving mad; and so *the controller era* was born. Controllers were crude at first, quite erratic, and somewhat unreliable. It was found necessary to establish special crews to service them along with the indicators and recorders of earlier years. Thus, Instrument Departments were born.

Under careful nursing and pampering by Instrument Men, coupled with improved design, these devices were coaxed into maintaining those all-important "standard conditions." However, process men and operators found that these standard conditions were not enough for continuous optimum high-quality yield. They were adequate for a given raw material, but unfortunately, in continuous processes particularly, changes in composition of feed stocks and reacting chemicals made the "standard conditions" less suitable. As a result laboratories were enlarged, and special sections were set apart for control (that word should be significant). Samples were taken periodically at designated points in the process stream and dispatched to the laboratory for analysis of properties. From these analyses the "standard conditions" were altered to meet new requirements. In short, despite the fact that the reaction environment is being held in steady state by conditions-regulating devices, the process is actually being controlled by property-analysis in the laboratory.

Please note that we have changed the tense of our verbs. We are in the present now. But to continue, this system violates one of the cardinal principles of Instrument Men, "keep controller dead-time to a minimum." We are accustomed to dead-times measured in seconds and minutes, whereas dead-time in this control system is a matter of several hours. Realizing the amount of product that can be slopped in this interval, foresighted process engineers are already demanding properties-measuring instruments for continuous service on process streams. Already some progress has been made in this direction. Devices for measurement, and sometimes control, of vapor-pressure, density, viscosity and color are already in service. pH, automatic titrimeters, refractive index indicators, end-point and initial-boiling point devices are already available. We are now entering *the analyzer era.*

As we enter this new age, we find that process engineers are still improving their machinery and other allied equipment, but not as fast perhaps as instrument manufacturers are developing their conditions-measuring instruments. Temperature instruments having a total span of 20°F. at elevated temperatures are now available; suppressed-range pressure instruments with 15-lb./in.^{2} spans and compensated for atmospheric pressure can be obtained; liquid level controllers that visibly respond to the addition or withdrawal of a few drops of fluid are on the market; and, in flow measurement, head meters are being developed with an accuracy approaching that of volumeters for some services. Pneumatic control mechanisms have been vastly improved, and mathematical methods for determining optimum controller settings have been worked out. Although such improvements will doubtless continue, most engineers agree that perfection of conditions-regulating instrumentation is not the final answer. Properties-measuring devices for purity and quality must be incorporated directly in the process.

The womb of development is fertile with ideas for these devices, but not all are in the gestation stage. Many of them are already born and are kicking around in that "cradle of instrumentation," the laboratory. It behooves the Instrument Department to look carefully at them to see what added responsibilities they will bring with them. Quite a few of them will be based on the electromagnetic spectrum; spectroscopes and spectrometers utilizing the many frequency bands that lie between the already explored limits, UHF radio waves at the low-frequency end, and x-rays at the high-frequency end. Already infrared, ultraviolet and the visible bands are doing yeoman service, in the laboratories. Refractive index, optical rotation and optical dispersion are other methods based on this phenomenon that will soon be used for process service. Other types will be based on a variety of potential measurements such as ionizing potential, ion concentration and the various kinds of polarographs. Both electrical and thermal conductivity will be used, along with ultrasonic vibration and possibly variations of the mass spectrometer. Automatic titrimeters will increase in usage.

These devices will be built as simple and rugged as possible but, regardless of all efforts toward simplification, such mechanisms will certainly be much more complex and involved than our relatively simple conditions-measuring instruments of today. A thorough knowledge of physics and higher mathematics will be required in repair and calibration. One responsibility immediately revealed by this extrapolation is that of providing suitable personnel for properly servicing such equipment. In general, we feel that this task is too great for the average instrument repairman of today. It will call for much higher intellectual ability and technical skill, probably necessitating an entirely new classification in our Instrument Department. These people would probably be classed as technicians rather than repairmen.

After having battled with employee groups, labor unions and even in some cases the lower levels of management, over educational qualifications, adaptability tests, advancement programs, etc., the Instrument Man is tempted to throw up his hands at this suggestion. A glance at the record, however, will reveal that he has always faced the problem of keeping his personnel "educated up" to the level required by the latest devices. The technological level of instrument personnel has been climbing all the time. The suggested additional personnel is merely another step up the ladder of progress. Regardless of all opposition, a means must be found to provide men suitably trained for the intelligent selection, proper installation and adequate maintenance of these devices of the future.

It is the responsibility of the Instrument Department to establish some method of keeping this personnel in touch with these developments so that selection can be based on sound judgment, if nothing more. It obviously is its responsibility to supply such personnel for supervising the installation of such equipment. If the contractor is unable to find labor capable of installing conventional instruments, certainly his men will be unable to correctly install these special mechanisms. Furthermore, it is the duty of the Instrument Department to extrapolate its requirements curves for maintenance facilities and begin negotiating for the necessary shop space, air-conditioned rooms, primary standards, special tools and other items for the proper repair and calibration of such equipment. From experience we would advise that, particularly in studies of shop space and air-conditioning, the Department look at least five years in the future — ten if possible.

We have said earlier that responsibility must be accompanied by authority, and doubtless the question of "where do we get the authority" has already arisen. We think anyone will have little trouble if he takes his problem directly to Management. There has been a tremendous change in the attitude of Management toward measurement and control in the last few years. This applies particularly to Top Management. In the lower brackets, probably because they are so close to the

forest they can't see the trees, certain individuals are likely to be lackadaisical or even antagonistic towards instrumentation. In the upper strata, however, enthusiasm runs high.

This is probably due to its dollar-and-cents value demonstrated during the war years, for Management realizes, as we do, that our processing plants manned with hastily-trained and inexperienced personnel would have been much less efficient had it not been for the measuring and automatic regulating equipment that kept them on the line in steady state. Furthermore, Management's attention is being called to instrumentation regularly. Such publications as *Business Week, Fortune,* the staid *Wall Street Journal,* and a host of others, now devote space to measurement and automatic control and the benefits to be derived therefrom.

This attitude of Top Management is being reflected in industry generally. We know of several large companies that periodically call in their Instrument Engineers to joint committee meetings for discussion of mutual problems and latest developments, and for the dissemination of information of general interest. We know of one company in which this movement has been extended even further. Each Instrument Engineer on this committee has been encouraged to organize within his own particular plant, or division, a field group or subcommittee whose duties are somewhat similar to, but possibly more complex than, those of the parent committee. Organization of such a committee in a typical plant consists of representatives from Management, the laboratories, the process design section, each operating department, instrument maintenance and instrument engineering sections. The group is normally headed by the Chief Instrument Engineer and meetings are held monthly. All information passed out from the parent committee is distributed to the ultimate user by these group meetings. In like manner, troublesome problems calling for new or improved equipment are collected through these channels and passed on to the parent committee. These are definite advantages over past methods, but they are only a fraction of the advantages to be realized from such a group.

Let us look at its possibilities in process design. As we stated earlier, our typical plant with its limited investment can ill afford to pay the salary of a first-class process-control engineer. Yet it must have available all the talents usually concentrated in such an individual, because process design in its normal course of progress is also entering the new era, *the analyzer era.* No longer is the plant laid out, equipment selected, and details completed before the flow sheets are turned over to the Instrument Department for "tacking on" its instruments. In most industries, at least some consideration is given to control requirements and instrumentation in original plant design.

Although this practice is not yet carried out to the degree that it should be, we are confident it will be in the future, because the idea is based on sound, logical reasoning. We build our plants to attain certain ends. To attain those ends the processes must be controlled, preferably automatically, since optimum yield and highest purity can thus be obtained. Controllability, then, is one of the primary considerations, and we predict that control requirements will play an increasingly important part in the construction and arrangement of all process equipment in the future. It is already realized that instruments are now being used to overcome faults that could possibly be eliminated by alterations to fundamental design and arrangement of equipment, and some corrective steps have already been taken. For instance, we no longer find a reciprocating pump supplied where the flow from it must be accurately measured. Likewise, most vessels are now arranged so that greatest benefit will result from liquid level controllers. Attention to such details will increase.

It is the personal opinion of the speaker that, in design of future plants, the mode of control will probably be considered first. Suitable instruments for establishing and maintaining this mode will be selected, and allied equipment will be chosen that, after incorporation of all other requirements, will best meet the needs of these instruments. Instrumentation will come into its deserved place in *the analyzer era,* and so will the process-control engineer. Although we do not have this individual in our typical plant as yet, in such a committee as that just described, we have all his knowledge. The only difference is that it is in three heads instead of one, but that is overcome by bringing the three heads, the Process Engineer, the Operator and the Instrument Engineer, together in committee meetings.

Proper selection of instruments, as we have said, depends not just on "knowing about" latest developments. To prevent buying "a pig in a poke," new devices should be tried out, evaluated. This is one of the functions of this organization. Each field group does a certain amount of test work each year with moneys assigned for that purpose; and its reports are circulated to all other participants in both the parent committee and field groups.

The interests of this organization embrace every phase of measurement and automatic control. It compiles standards, distributes educational texts and films, performs many services other than disseminating information and solving specific problems. Perhaps the greatest justification for its existence is the link this organization forms between the process designer and the instrument manufacturer. Earlier we compared the relationship of these agencies to participants in a three-legged race. We have seen such races in which a pair achieved remarkable speed. Their secret was coördination, and this committee constitutes coördination between these two agencies.

The primary consideration in setting up this organization was, of course, profit. Logically one might expect it to be a closed circuit, a rather secret group whose findings are regarded as strictly confidential. But such is not the case. Emanating as it does from Top Management, this movement is apparently motivated by the highest of ideals. This committee has been instructed to work openly and freely with anyone interested. No secrets are withheld. Its reports are, of course, restricted to circulation within the company and there are a few items involving patent rights that must be regarded as confidential until sufficient coverage is obtained. But the bulk of its findings are available to industry simply for the asking.

There is evidence of other high ideals, too; some that Instrument Departments in general would do well to emulate. Speaking before this committee, the President of this particular company laid heavy emphasis on the fact that this committee's activities should never be directed toward throwing men out of work. Its function is to increase man's productivity, to make more goods for more people at less cost and with less physical labor. This, we think, exactly expresses the feelings of all Instrument Men, but the idea can well use more publicity.

A little thinking should convince even the most illiterate person that the progress of mankind since the dawn of civilization has been dependent on technological advancement. Yet, we find a relatively large number of our people, some of them comparatively well-educated, who oppose every innovation in applied science on the theory that it throws people out of work. Such people constitute a menace to our profession, and their theories can best be opposed by common-sense counter-propaganda. It is the duty of every Instrument Man to let the public know that he does not intend to deprive anybody of his job. He must explain to everyone concerned the peculiar paradox that in the last analysis instruments, create, rather than destroy, jobs.

Actually, the Instrument Man's attitude toward society should be benevolent. His aim should be a social order in which *no one ever has to work very hard.* The Instrument Man has a particular obligation in this regard. He has in his hands ways of amplifying feeble forces to shift great weights; means for effortless solution of complex mathematical problems; methods for controlled distribution of great quantities of energy. And yet, we find that, of the millions of horsepower utilized each day, a large portion is controlled by back-breaking manual methods. Truly, the Instrument Man's horizons are infinite.

It is his responsibility to keep his standard high, his march militant.

Preventing Mechanical Erosion of Thermometer Wells and Stems

By A. H. LAMB, Chief, Relay and Thermometer Engineering Division, Weston Electrical Instrument Corp., Newark, N. J.

MECHANICAL erosion of thermometer stems, thermowells and protective sockets by the impact of solid particles conveyed by air blast or suction is a particularly troublesome problem but one which is readily overcome by fairly simple means. When one considers the similarity between air blast conveying systems and the familiar sand or grit blasting, it becomes apparent that the same type of erosion can be anticipated. Erosion caused by particles in the air-blast conveying system is continuous and uncontrolled and may cause considerable damage before detection. While ducts of such systems are generally designed with this problem in mind, the accessories such as thermometers are necessarily designed for the primary function, temperature measurement, and must be protected against mechanical erosion by some means of installation designed to minimize the effect of such abrasion.

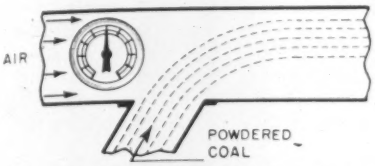


Fig. 1. Thermometer can be installed in the heated air stream just before the powdered coal is injected.

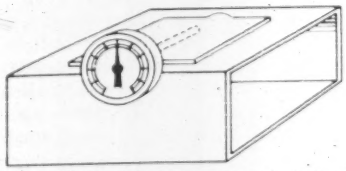


Fig. 2. Using the thermometer to indicate surface temperature.

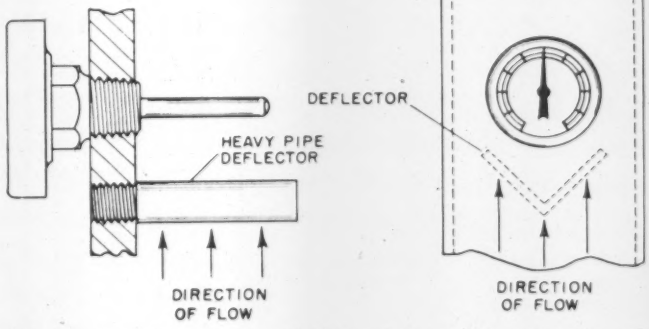


Fig. 4. If the thermometer can not be moved it is recommended that deflectors be installed as shown.

Powdered Materials Most Troublesome

Of the various pulverized or powdered materials such as coal, coke, lime, cement, and similar substances handled and moved by suction or blowing and of which temperature determination is of importance, coal and coke are by far the most troublesome. Certain industrials find coal the most convenient and economical fuel and generally purchase "run-of-mine" lots which vary from large lumps to relatively large grains. This coal is then passed through some type of ball or hammer mill where it is pulverized, after which it is moved by air to storage or directly to the combustion chamber.

It is common practice to pre-heat the air-powdered-coal mixture before its entrance into the combustion chamber by admitting heated air into the conveying ducts. The mixture is maintained at a temperature of 275-300°F. or thereabouts, but generally not above 350°F. because of the danger of preignition, which might blow out or severely damage part of the equipment or at least shut down the fire.

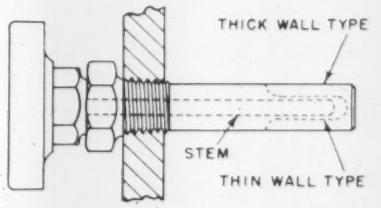


Fig. 3. Sketch showing the use of the thermometer with a protective socket.

The correct operation of the thermometer is therefore very important, even critical, so that it behooves the operator to see that it is installed properly for permanently accurate temperature indication.The only damaging influence encountered in this type of installation is the eroding action of the powdered coal as it hits the stem or socket. If placed directly in the stream of powdered coal, the wall of a stem may wear away completely in a few days, a regular socket in a few weeks, and a heavy duty socket may last six months to a year or two. Since the destruction is one of pure mechanical abrasion and tear and certainly not of thermometry, the solution is one of simple mechanism.

Solutions to the Erosion Problem

The best solution, where applicable, is to place the thermometer stem or socket where it will not contact the coal particles: in the heated air stream just before the powdered coal is injected. See Fig. 1. Next best from the accuracy standpoint is to use the thermometer as a surface thermometer outside of the housing as shown in Fig. 2. By attaching the thermometer in such a manner that the stem rests against the outside metal surface, and covering with a patch of insulation (lagging) the thermometer will indicate skin or surface temperature which, in most cases, will be within a few degrees of actual powdered coal temperature.

If for some physical reason the thermometer must be placed where the stem will be in direct contact with the powdered coal, certain minor variations in adapting the thermometer may alleviate the erosion. A heavy duty, thick-walled socket may be used or a suitable baffle or deflector can be installed. See Figs. 3 and 4. The socket or thermowell need be used only if it is desired to be able to remove the thermometer without leaving the resulting opening, Fig. 5.

In some installations the use of a short-stem thermometer has given very good results in retarding erosion by keeping the stem out of the direct flow of coal. Fig. 6 shows the installation of a short-stem thermometer.

One or more of these schemes should afford adequate protection for the thermometer against erosion and also against larger stray pieces of coal, slate, iron, etc., and in the long run, maintenance costs will be reduced, but—more important—the thermometer will be permitted to perform its intended function: to measure temperature correctly and accurately and to protect life, property, and profits.

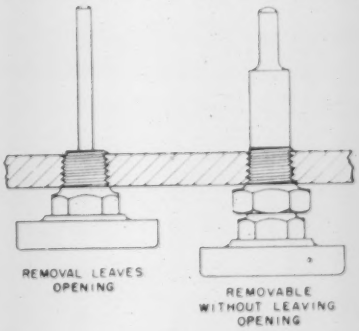


Fig. 5. The above sketch illustrates the use of the thermometer with and without its protective socket.

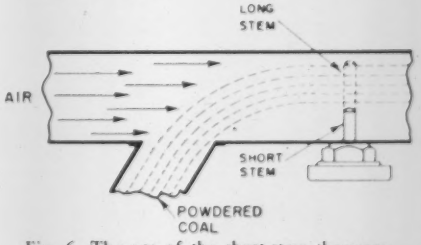


Fig. 6. The use of the short-stem thermometer is another solution to the erosion problem.

Novel D-c. Selsyn A

By R. L. MOELLER, Aircraft Instrument Section, Meter and Ins

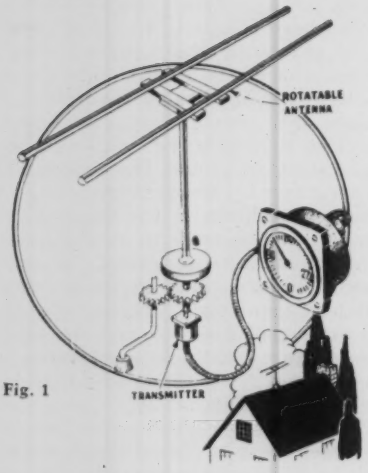


Fig. 1

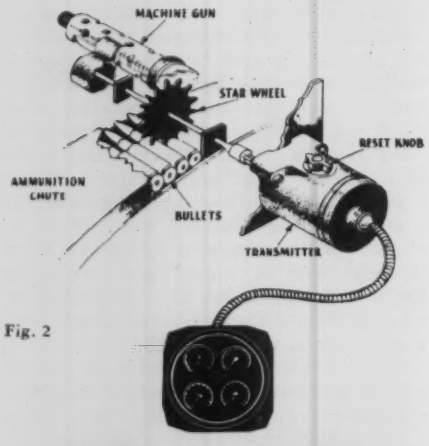


Fig. 2

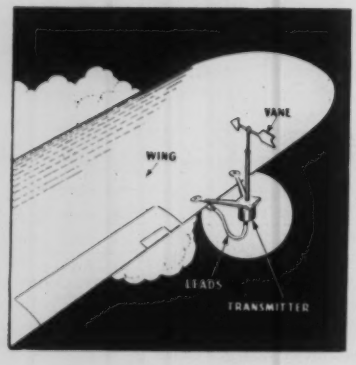


Fig. 3

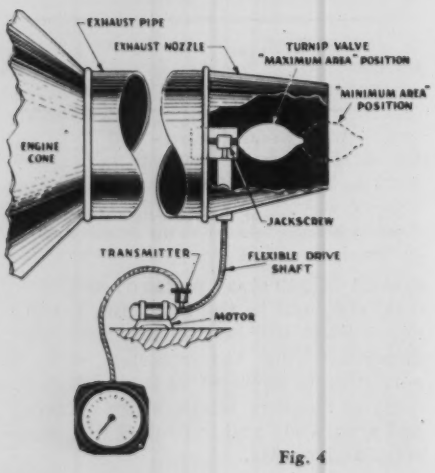


Fig. 4

IN addition to the widespread application of d-c. Selsyn indicating equipment to aircraft, many other practical uses have been devised to take advantage of the versatility of this equipment. A Selsyn of the variety here considered might be described simply as an electrical system for measuring a variable, transmitting the result to a distant station, and there indicating the measured value. It should be noted that although other telemetering systems are available, this article deals only with a d-c. type which is small in size, relatively inexpensive, and operates normally from a 12- or 24-volt direct-current source.

A practical design of this d-c. variety consists of a transmitter with a toroidal resistance winding and an indicator containing a field structure and a polarized rotor. Interconnections between three field coils mounted on the field structure are connected to three taps from the transmitter coil. Direct current is applied to any diameter of this coil by means of two brushes. The position of these brushes determines the current flowing in each of the three indicator field coils. These three currents, in turn, determine the flux pattern which positions the polarized rotor and the attached indicator pointer.

An inexpensive power-supply adaptation kit consisting essentially of a rectifier and transformer permits the use of the direct-current system where only alternating current is readily available. Since the d-c. Selsyn system can tolerate comparatively large changes in supply voltage with negligible changes in accuracy, the system can be used even where large line drops due to lead resistance are present. Distances of one or two miles between the transmitter and indicator are entirely practical.

Besides doing what is now considered the routine job of indicating landing-gear, oil-cooler flap, cowl-flap, and landing-flap position on aircraft, d-c. Selsyn equipment has indicated the direction of air flow over an experimental airfoil, registered manifold pressure of marine engines, shown the position of rudders on ships, and has indicated the position of variable nozzles in jet engines.

The following is a group of typical applications:

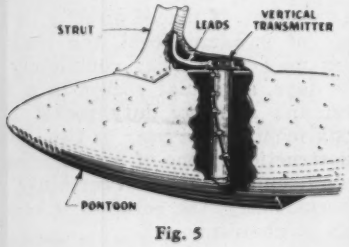


Fig. 5

Antenna-position Indicator. To give a radio "ham" an indication of the position in azimuth of his rotatable antenna mounted on the roof top, a transmitter is so connected to the antenna shaft that its shaft rotates the same amount as the antenna (Fig. 1). The indicator supplies a continuous reading.

Ammunition-rounds Counter. As the name implies, this device indicates to the pilot (or gunner) the number of rounds of ammunition remaining in each machine gun. For this application, a transmitter is mounted directly on each ammunition chute or close to it. As the bullets pass down the chute, they actuate a star wheel which in turn rotates the transmitter shaft through a set of reduction gears (Fig. 2). Mounted in the cockpit is an indicator with a dial graduated in rounds of ammunition. Provided on the transmitter is a reset knob so that the indicator pointer can be set to the same number of rounds of ammunition as loaded into the gun.

Yaw Indicator. During flights of experimental aircraft it may be desirable to know the direction of air flow across the wing. This information can be obtained by the use of a vane and transmitter mounted at the wing tip (Fig. 3). The transmitter is driven by the vane shaft and is connected electrically to the indicator in the cockpit. When the direction of the vane is parallel to the axis of the aircraft the indicator reads zero. During flight the pilot merely reads the indicator to note the amount of "yaw" of the airplane.

Variable-area Nozzle. In order to achieve a flexible and rapid method of thrust control in jet engines, the area of the exhaust nozzle is varied by moving a "bullet" or "turnip" type valve to occupy different positions in the exhaust nozzle. An exact indication of the position of the valve is given the pilot by the combination of a Selsyn indicator in the cockpit and a transmitter geared to the electric-motor drive, which is controlled by the pilot to position the valve as dictated by flying conditions. (Fig. 4).

Gasoline Tank in Pontoon. In order to utilize all available space on an aircraft for gasoline storage, portions of seaplane pontoons are made gasoline-tight. Since bracing members passing through the tank make it impracticable to use a conventional gasoline liquid-level transmitter of the swinging-arm-and-float variety, a vertical-type transmitter is used (Fig. 5). A shield provides protection against salt-water spray and also acts as a cover for the leads to the indicator, which are brought up inside the strut supporting the pontoon.

APPLICATIONS

Instrument Division, General Electric Company, West Lynn, Mass.

Explosion-proof Pressure-indicating Equipment. In explosive atmospheres the possibility of an electric spark cannot be tolerated. To secure the advantages of remote-indicating pressure equipment in oil field applications, conventional transmitters and indicators are enclosed in explosion-proof casings with resulting satisfactory operation.

Multi-station Indication. In the recording of experimental data it often becomes necessary to advise operators at remote stations which test point is being read. A multi-station Selsyn system solves the problem. Five indicators, each with as many as twelve scaleplate numerals, are operated from a single transmitter of a special step type. The transmitter shaft is set by the control operator and each indicator immediately shows this value.

Position Indication for Scale-model Aircraft. For some time it was conventional practice to place a scale model in a wind tunnel and then to adjust the control surfaces at the desired setting before starting the test run. After the run at a certain setting was completed, the tunnel was shut down, the setting of the control surfaces changed, and another run started. This practice has been made obsolete by the method now in use which operates the model by remote control. The control surfaces may be changed to any desired setting while the tests are in process, and an accurate means of position indication is accomplished by the use of transmitters mounted inside the model. Indicators showing the position of each control surface are mounted on a control panel in front of the wind-tunnel operator.

Mobile Steam-power Plant. Conventional aircraft Selsyn equipment is utilized on mobile steam-power plants which are used to provide emergency power at any desired location. The Selsyn equipment consists of liquid-level indicators to give a remote indication of the distilled water and the oil in the various bunkers of the power plant.

Rudder-position Indicator. To tell the pilot of a boat the position of the rudder a Selsyn transmitter is geared to the rudder and the indicator is placed in the pilot house (Fig. 6). The indicator, therefore, provides a continuous indication of the rudder position. Installations of this type generally require a large-diameter indicator since ship operators find it difficult to become accustomed to small-size indicators such as used on aircraft.

Turbosupercharger - wastegate Position Indication. On test flights of experimental turbosupercharger installations it is necessary to know the exact position of the turbosupercharger wastegate. This indication is necessary to obtain test results on the amount of gases that are being passed through the wastegate. The installation utilizes a linkage attached to the shaft of the wastegate and also to the position transmitter (Fig. 7). Because of the intense heat radiated from the turbosupercharger, it is necessary to mount the transmitter within the fuselage of the aircraft. A conventional indicator mounted on the instrument panel provides the pilot with a continuous indication of the wastegate position.

Manifold-pressure Indication on PT Boats. To give accurate indication at the bridge of the manifold pressure of each engine installed in Navy PT boats, d-c. Selsyn pressure transmitters are shock-mounted in the "V" of the engines (Fig. 8). Flexible hose connections are attached between the transmitter and the engine manifold. High operating temperatures, compared to aircraft use, are generally encountered in applications of this nature.

Cable-car-position Indicator. Owing to the length of track, cable cars pass out of sight of the control operator. To advise the operator the location of the car, a position transmitter is geared to the drum shaft of the cable winch (Fig. 9). A set of reduction gears is utilized so that the entire range of travel of the car results in only one revolution of the transmitter shaft. The indicator is graduated in feet with zero corresponding to the position of the car when it is closest to the winch.

Weather-vane Indicator. A natural application for the d-c. Selsyn system is the indication at a remote station of the direction of a weather vane. The transmitter is connected or geared to the vane itself and the indicator placed at some indoor location where it can be read conveniently (Fig. 10).

From the variety of these applications, the versatility of the d-c. Selsyn system of remote indication is obvious. It is logical to expect that new applications will continue to be found in widely scattered and diversified industries. Some will use the basic system unaltered; others will require modifications. However, the soundness of the method has been confirmed by the hours of satisfactory operation accumulated to date in numerous applications.

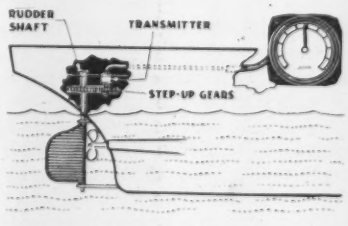
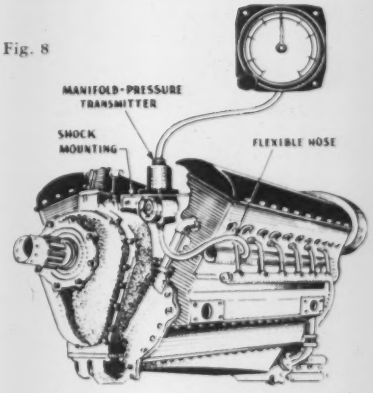


Fig. 6

Fig. 7

Fig. 8



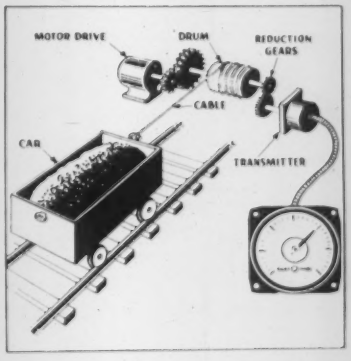


Fig. 9

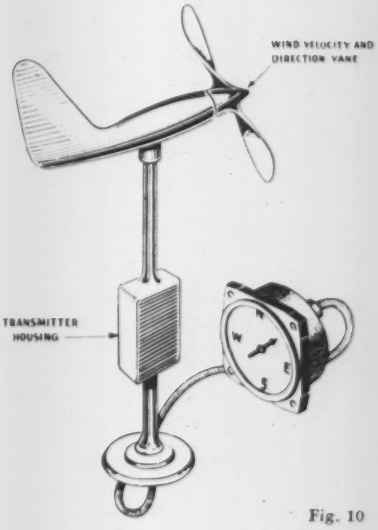


Fig. 10

The Statistical Quincunx

By JAMES A. FIZZELL, Engineer, Illinois Testing Laboratories, Inc., Chicago 10, Ill.

DURING the war years, when ingenuity was so actively stimulated to "do the job better and faster," old but little-known ideas and methods were revived and adapted to the requirements of the emergency. When the War Production Board undertook to teach Industry the statistical methods of quality control, it was offering a comparatively modern and extremely useful adaptation of the laws of probability which were studied over a hundred years ago largely for the benefit of gamblers. The teaching of these statistical methods brought into greater prominence an old museum and university curiosity known as the STATISTICAL QUINCUNX.

Invented by Sir Francis Galton in the latter part of the 19th century, the quincunx is capable of demonstrating the natural law of probability in a few minutes—more dramatically than it can be shown by other laborious, time-consuming methods. Because the statistical quincunx can build up a frequency distribution curve before one's eyes, it is helpful today in training quality control men and in showing machine operators how the distribution of dimensions is formed in a machine which is operating correctly.

Fig. 1 shows the statistical quincunx which was demonstrated at the 1947 Instruments Exhibit. It was set up as a sort of allegorical mechanism wherein a supply of small identical steel ball bearings in the hopper at the top of the board represented MATERIALS; the single wheel which revolved at the bottom of the hopper represented MACHINES; and the array of pins represented MEN. All of these factors contribute to the accuracy of a manufactured product. In this allegory, the process being symbolized had a "controlled accuracy of ±1% which was indicated by the fact that about 995 of the 1000 steel balls always fell in the distribution between the "1%" points on the lower scale. In repeated trials, the general shape of the distribution approximates the normal probability curve.

The quincunx derives its name from a contraction of two latin words and an interesting pattern to which they referred. In the days of the Old Romans, the five-ounce weight was marked with a pattern of five spots arranged in the corners and center of a square. This pattern is familiar to all of us as the "five-spot" on dominoes of either the static or the galloping variety. It was also familiar to the Romans and was called the *quinque uncia* (five-ounce) mark, which name was shortened to *quincunx*. In the planting of orchards this is the pattern used; and in the arrangement of the pins in the quincunx shown in Fig. 1, this same pattern was reduplicated many times.

In order to explain the variations which occur in manufacturing processes, the "Percent Error" scale at the bottom of the quincunx may be altered to show millivolts, amperes, degrees, thousandths of an inch, pounds, or almost any measurable magnitude. Since, however, all of these can be expressed as percent error from some nominal or specified figure, the chosen scale is almost universal. Of course, not all distributions are as nearly "normal" as the ones displayed on the quincunx, but the comparison is quite satisfactory.

There still prevails in some quarters the idea that a really accurate machine is capable of making nearly all of its parts exactly alike. Unfortunately this is not true of *any* manufacturing process and the people who are to control a process must be given an understanding of the fact that variations do occur in all processes and that in a truly controlled process they occur according to a fairly definite pattern.

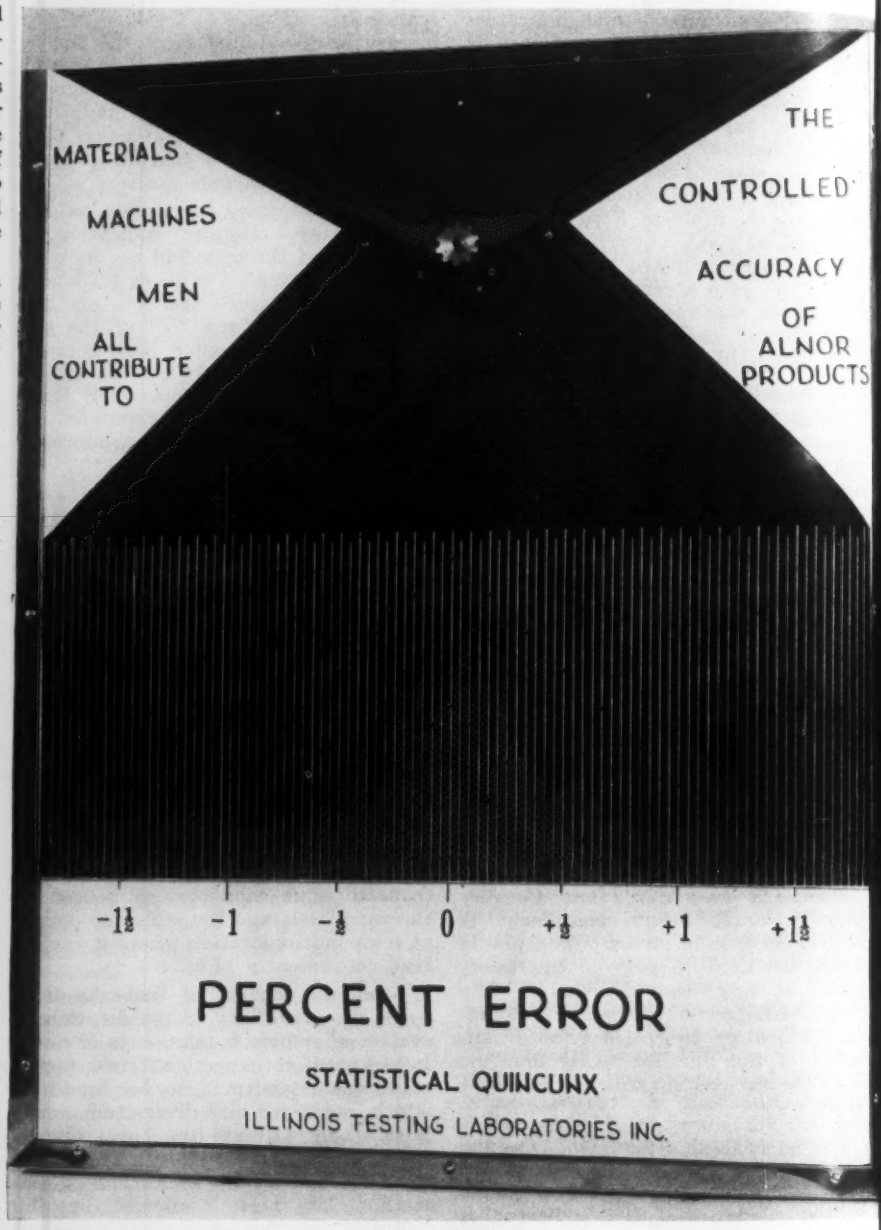


Fig. 1

As an example of the way to discover the truth of this latter assertion, let us inspect and chart the findings of a shipment of small glass thermometers. From a shipment of small glass thermometers, 60 are removed and placed into a water tank along with a large certified Standard Thermometer. When the temperature of the water has

stabilized, the readings of all the thermometers are taken and the error shown by each thermometer at this one temperature is computed by comparing it with the Standard Thermometer. These errors are shown in Table I.

TABLE I

ERRORS IN DEGREES FAHRENHEIT

0.0	−0.3	+0.5	−0.1	−0.4
−0.2	0.0	+0.1	+0.2	+0.2
+0.7	−0.4	−0.4	−0.4	+0.1
+0.7	−0.3	−0.4	+0.4	0.0
+0.2	−0.6	−0.4	−0.4	−0.3
+0.1	+0.4	−0.2	−0.2	−0.4
−0.4	−0.1	+0.1	+0.2	−0.1
−0.2	−0.3	0.0	−0.3	−0.1
−0.4	−0.2	−0.5	+0.6	−0.1
+0.1	−0.2	−0.5	+0.1	0.0
−0.4	0.0	−0.1	−0.2	−0.6
−0.9	−0.3	−0.6	−0.4	−0.6

Now let us draw a horizontal line on a piece of paper and mark off along it several divisions to form a scale on which each division represents an error of one-quarter of a degree. Since there will be both positive and negative errors, the scale should extend to both sides of a vertical "zero" or reference line. When this scale is prepared, we can systematically go through the data and draw an X above the appropriate section of the scale for each magnitude of error. This has been done in Fig. 2.

In looking at this chart one can see that three thermometers had errors on the high side between 0.5° and 0.75°; and one thermometer had an error greater than 0.75° on the low side.

Although 60 units constitute too small a sample to form a smooth distribution, even this small sample conveys the idea of a single frequency distribution and leads one to infer that these thermometers must have been made in a well-controlled process. By applying mathematical statistics to these same data, one can learn more definite quantitative information about capabilities of the process. In this particular investigation, an additional sample consisting of 66 thermometers was tested and all of the data were computed together to show that the limits of the process were ±1.2°. From this example one can see that the process of thermometer manufacture yields a frequency distribution quite similar to the one shown by the quincunx. It has a strong central tendency and definite limits of dispersion.

Experience with other products has shown that if one measures the length of a batch of pins which have been cut off by an automatic machine and constructs such a chart as the one shown in Fig. 2, a similar distribution should be accumulated if the machine were operating in control. The same is true of the products from an automatic screw machine or of the errors made in reading an instrument. Because of the amount of time and labor involved in making measurements, it is much easier to use the quincunx to build up these frequency distribution curves for educational purposes than it is to construct them from raw data.

The essential facts to be learned from watching the formation of the various frequency distributions from manufacturing processes are that all of the distributions have: (1) a central tendency denoted by the average of all the readings and (2) fairly definite limits to the extreme values (highest and lowest measurements) within which nearly all of the measured values should lie. In

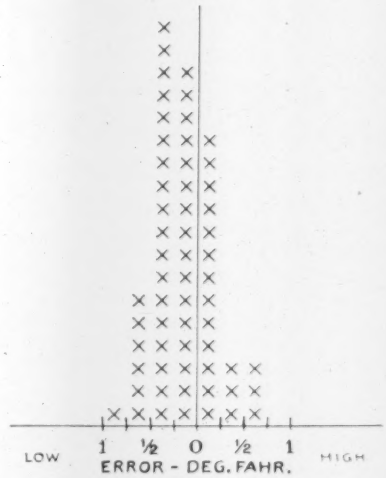


Fig. 2

practice, these characteristics can be learned only by taking some measurements on the particular variable in the product being studied. With these measurements, one can compute the average to determine the central tendency and one can plot a frequency distribution as we have done with the thermometers to estimate the limits of the distribution and to determine whether these limits fall within the specification limits. Unfortunately, this graphical method requires from 600 to 1000 measurements in order to yield reliable information about the limits. It happens however, that by the use of mathematical statistics, one can compute with good accuracy the practical limits from as few as 30 measurements when they are a random sample from a well-controlled process.

Trained quality control men have learned to do this work for industrial processes and have proved that when one has established the characteristics of a process, one can tell by taking only a small sample whether that process appears to be changing in its performance. In other words, a large sample is desirable to provide the initial picture of the process, just as the quincunx provides the fairly complete distribution, but a small sample will usually tell whether the process appears to be deviating from that initial picture. Since one can also take small samples on the quincunx, it is possible to demonstrate by such samples that there has been a change in its "process" such as a tilt of the board to one side. This system of taking enough data to establish the capability of the process and then taking a series of small samples to keep an eye on the subsequent performance is the basis for statistical control of manufacturing processes.

The ability of the quincunx to demonstrate to designers the inherently statistical nature of the output of a machine or other manufacturing process is important. It aids rapidly in developing the ability to think in terms of a frequency distribution. Great stress has been laid upon the relation of production limits to specification limits but insufficient attention has been given to the relation of specification limits to process capability. Before the wide dissemination of statistical knowledge, it was almost impossible for designers to have an accurate picture of the capabilities of the machines which were to make their newly-designed products. The difficulties normally associated with putting a new item into production were worsened by attempts to make various items to closer tolerances than were either necessary or feasible. This was strongly demonstrated in the early days of the war when so many new products were being demanded of industry and the specification tolerances sometimes appeared to be rather arbitrary.

Every scientific aid which can be furnished to assist the judgment of the designer makes life a bit easier for the production man who is to take over the job of manufacture. What aid could be more valuable than a knowledge of the type of frequency distribution normally produced by each of the various machines that are expected to be used in the manufacturing operations? The picture presented by the quincunx forcibly shows the balancing of the distribution around some central or nominal figure and it discourages the old idea of "hugging" one limit and expecting to find only a few items dispersed toward the other limit. If this arouses the interest of the designer, he will find that there is great opportunity for coöperation between himself and the quality control man who can supply accurate statistical information about actual performance of the manufacturing processes.

The role of the quincunx for educational purposes is many-fold in a manufacturing plant which is seeking to train the personnel to think in terms of statistical methods of quality control. It can show the men at the machines the manner in which their machines produce a "family" of dimensions and can teach them to expect a certain range of dimensions. It can aid inspectors to visualize the relation between specification limits and the normal limits of a machine or process. And it can demonstrate to designers the manner in which they must regard the variations in manufacturing processes when they are determining the tolerances for dimensions and weights or electrical, thermal and chemical characteristics in their new products.

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

XV. DESIGN AND CONSTRUCTION OF DISTILLATION EQUIPMENT

The advancement of the distillation art in the last twenty years has been very encouraging. The development of packing for fractionating columns, along with new techniques and construction details, has made it possible to separate complex mixtures both on a commercial and laboratory scale. Research chemists find that fractionating columns can be advantageously used to purify compounds for chemical synthesis. The problem of identifying synthesis products is also simplified. The cost of setting up such columns need not be high. In fact, with a little ingenuity, a simple fractionating column can be set up in the laboratory at a reasonable cost. The improved commercial columns have also decreased the cost of many chemicals. These chemicals which have a relatively high degree of purity are now available in tank car lots.

A discussion of the entire distillation art cannot be given, nor will it be necessary to discuss commercial installations. It will suffice to describe equipment which is used in the laboratory, with special emphasis on construction details.

A discussion of laboratory distillation columns should logically cover the entire range of separations which are encountered in the laboratory. To accomplish this end, it will be necessary to divide the equipment into the following four groups:

1. Fractionating equipment for separating normally gaseous compounds.
2. Fractionating equipment for separating compounds with boiling points at atmosphereic pressure up to 250°C.
3. Vacuum fractionating equipment.
4. Molecular or short-path distillation equipment.

The development of equipment listed under 1, 2 and 4 has greatly surpassed the development of vacuum fractionating equipment. Recent research trends have shown that this equipment is in demand and is certain to receive attention in the future.

The division of fractionating equipment into these four groups does not imply that the equipment is restricted to its respective group. A certain amount of flexibility is possible. It should be pointed out, however, that there are definite limitations of laboratory columns in each group. Laboratory technicians should be aware of the shortcomings of columns when they are used under different operating conditions.

Definition of Distillation Terms

A discussion of distillation equipment can best be understood if one is familiar with the terminology used. The terms which will be used in this discussion are as follows:

1. *Stillpot.* The flask or container in which the charge is vaporized.

2. *Boil-up* rate. The amount of charge vaporized in the still pot in unit time.

3. *Packing support.* Support in the column which holds the packing in place.

4. *Height of Fractionating Section.* Height of packing or bubble plate section in column. A small amount of fractionating is obtained in the condenser and vapor tube leading to the condenser as well as between the stillpot and column. The term as used here will apply only to the length of the packed column.

5. *Packing.* Inert material in the fractionating section which permits intimate contact between vapor and liquid by virtue of its surface area.

6. *Free Space.* Space in fractionating column not occupied by packing. This void space can be determined by filling a graduated cylinder to the zero mark with packing and determining the void space by adding a non-volatile liquid. The volume of this liquid required to fill the graduate to the zero mark is the free space.

7. *Vapor velocity.* Linear velocity of the vapor through the fractionating column. Space occupied by reflux and packing material is neglected when vapor velocity is calculated.

8. *Hold-up.* The operating hold-up of a distillation column is the amount of liquid and vapor in the distillation column when the column is being operated. The amount of liquid that does not drain from the column when operation has ceased is the static hold-up.

9. *H.E.T.P.* The height equivalent to a theoretical plate.

10. *Theoretical Plate.* A plate in which the ascending vapor in the column contacts the liquid so completely that all vapor is in equilibrium with the liquid.

11. *Pressure Drop.* The pressure drop is the difference in pressure between two points in the fractionating section, usually between the bottom and the top of this section.

12. *Total Still Head Condenser.* The part of the distillation column where all vapors from the fractionating column are condensed.

13. *Partial Still Head Condenser.* The part of the distillation column where a portion of the vapor from the fractionating section is condensed and returned to this section. The remaining vapor is condensed in a second condenser and removed as product.

14. *Reflux.* Condensed vapor which is returned to the fractionating section.

15. *Reflux Ratio.* The ratio of the amount of liquid returned to the fractionating section and the liquid removed at the condenser as the distillation product.

16. *Total Reflux.* Total return of the condensed vapor to the fractionating section.

17. *Batch Distillation.* Process in which a definite amount of liquid is charged to the stillpot. This liquid is vaporized and condensed into fractions, each of which may vary in composition.

18. *Continuous Distillation.* Liquid is charged to the column at a definite rate. Several products are removed from the column. The composition of each product is different from the others, but in itself has a constant composition.

19. *Rectification.* A distillation process where the condensate or reflux is brought into intimate contact with the ascending vapors causing a heat and material change between the two phases. The vapors are enriched in the more volatile components by the heat exchange, and consequently, the liquid phase is enriched in the less volatile components.

Operating Requirements of a Fractionating Column

A theoretical discussion of the rectifying principle of separating various components in a mixture need not be given. A thorough treatment of the theory of distillation and vapor-liquid equilibria data can be found in numerous articles covering the art of distillation. The design and construction of fractionating equipment does demand a certain amount of knowledge concerning the function and operation of the column. Certain requirements must be set up for satisfactory column operations. The degree in which these requirements are met will determine to a great extent the operating efficiency of the fractionating column. These requirements are as follows:

1. A constant and uniform vaporization must take place in the stillpot.
2. The rectifying section of a column must be adiabatic.
3. Intimate contact between descending liquid (condensate from the still head condenser) and the ascending vapors from the stillpot is necessary.
4. Adequate and constant reflux must be maintained to the rectifying section.
5. Means must be provided for dividing reflux and the distillate product.

The importance of a uniform boil-up rate in the stillpot has received very little attention in fractionating columns. These columns operate on the principle of establishing equilibrium between the vapors and liquid in the fractionating section. Uniform vapor flow is more advantageous than uneven flow. To obtain a uniform vaporization rate, consideration must be given the stillpot surface as well as the method of heating the stillpot. A method of maintaining a more uniform vaporization will be discussed under the description of the stillpot.

Fractionating columns should be adiabatic because of the equilibrium desired between the vapors and reflux in the volumn. Lateral heat flow from the column cannot be toler-

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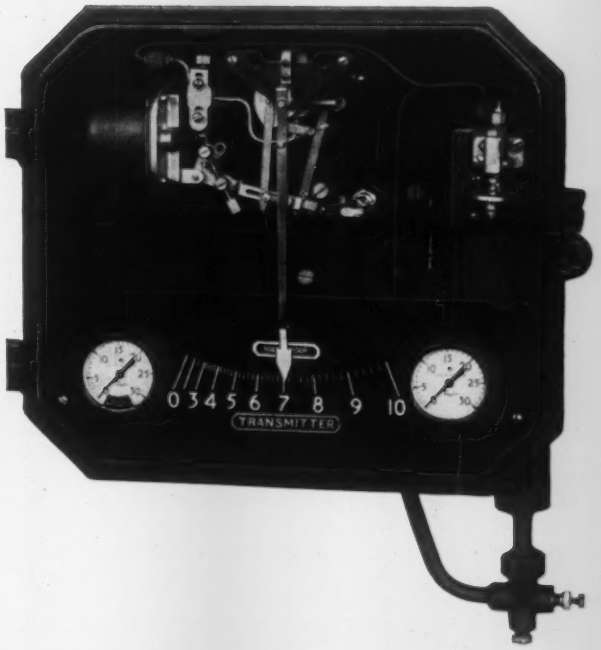

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ated if very efficient rectifying columns are required. All heat exchange should take place between the two phases in the column and not with the column walls. Excessive heat loss in small sections will cause condensation which favors flooding of these sections. The attainment of equilibrium cannot be expected under these conditions. On the other hand, if too much heat flows into the columns from the outer wall, i.e., if heaters are placed on the wall, heat exchange between the two phases alone cannot be obtained. Vaporization will result, depleting the column of scrubbing liquid. Various methods for approaching adiabatic conditions in laboratory columns will be discussed in another section of this chapter.

The fractionating section of a column may be viewed as a number of consecutive simple distillations. Vaporization and condensation takes place in this section by virtue of the heat and material exchange between the liquid and vapor phases. High boiling components are scrubbed from the ascending vapor and low boiling components in the reflux or liquid are vaporized by the heat released by the condensing process of the high components. The extent and rate to which this interchange of heat condensation and vaporization takes place depends on the intimate contact of the two phases. Numerous column packings have been studied and results of some of these studies will be given under column packings.

The importance of maintaining adequate reflux need not be stressed in view of the discussion in the preceding paragraph. The column when operating under specified conditions will approach the equilibrium which is possible at the predetermined conditions. If the reflux ratio is low, very little rectification can be expected due to lack of adequate scrubbing action in the column. If the reflux ratio varies during the distillation, a variance in the equilibrium of vapor and liquid will be obtained, and consequently, the degree of rectification must change.

The removal of distillate must be controlled. The reflux ratio has been defined as the ratio of the amount of reflux returned to the column and the amount of product taken from the column. If the removal of the product cannot be controlled, the column equilibrium will be affected in the same manner as a change in the reflux ratio.

The Distillation Column

The Stillpot

The round-bottom flask is the common form of stillpot for laboratory fractionating columns. This flask is sometimes sealed directly to the column. The use of the ground glass joint, however, is the most common method of attaching the stillpot to the column. The spherical ground glass joint has gained considerable favor over the tapered joint because the latter is likely to freeze under some operating conditions. The spherical joint can be used to good advantage if it is carefully cleaned. A certain amount of flexibility is obtained since the still pot need not be exactly in line.

The stillpot should be of suitable size to accommodate the charge and should contain a thermowell. The liquid in the stillpot can be overheated especially if high boiling components are present in the charge.

A tube, sealed to the stillpot above the liquid level, is also required if a manometer is used to measure the pressure drop through the column. A spherical joint sealed to this tube obviates the danger of subjecting the side tube to tension when the connecting tube between the stillpot and manometer is not perfectly aligned, Fig. 189.

The method by which the stillpot is heated to give even boiling does deserve some consideration. Several ways of heating the charge in the stillpot are: by use of an open electric heater, a gas flame, a heated oil bath, or an electrical heater enclosed in a metal container which fits around the stillpot. The use of some of these heaters should be discouraged. The glass-cloth-covered electric mantles sold by the Glas-Col Apparatus Company of Terre Haute, Indiana, are very good. These mantles allow exact heat input by using a voltage-regulating transformer such as the Powerstat or Variac. They cover the entire stillpot, eliminating the danger of breaking the flask and can be purchased for any flask size. These mantles are light. They can be supported by special spring supports which hold the stillpot and column joints together with the desired tension. Linear expansion of the column is possible because of the springs.

The problem of heating the charge in the stillpot so that a minimum amount of superheating is obtained is not readily solved. It has been noted that a more uniform boiling rate is obtained if the inside wall of the stillpot is coated with small glass particles of 50 to 60 mesh size. These particles are partly fused to the flask in the following manner: A portion of powdered glass, (Pyrex 774) of 50 to 60 mesh, estimated to cover the wall of the flask (Pyrex 774), is poured into the clean flask. A suitable holder is then fastened to the flask opening. The flask is slowly and uniformly heated in a large flame until the powdered glass begins to cling to the inside surface. At this point the flask is heated and rotated in such a manner to give a uniform coating without fusing the powdered glass to the extent that the surface becomes transparent. When an opaque and uniform surface is obtained the flask is carefully annealed and allowed to cool.

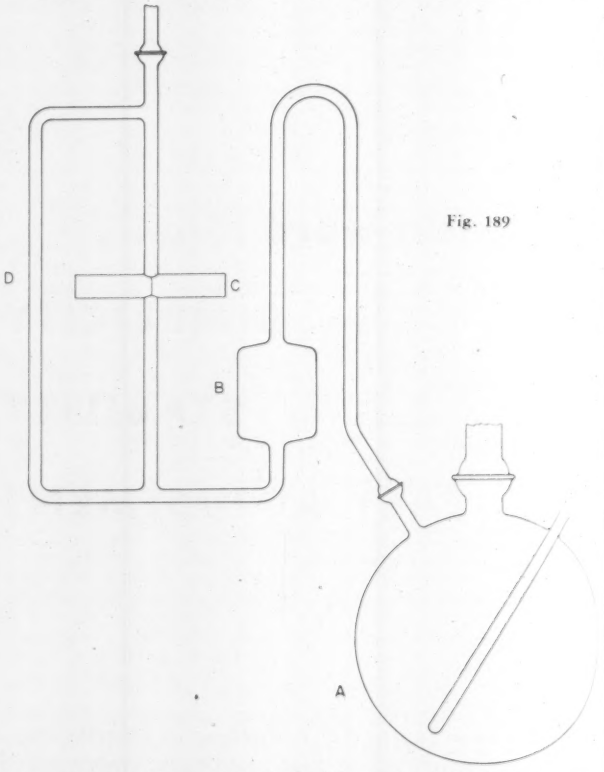

Fig. 189

Immersion heaters with low heat capacities are also being used for heating the charge in the stillpot. These heaters have the advantage of low heat capacity and immediate response to electrical current changes. They must extend to the bottom of the stillpot if all material is to be distilled. Side-arm openings or glass-to-metal seals in the flask are required when such heaters are used.

Pressure Drop Control

The pressure drop through the packing of a fractionating column is a measurement of the boil-up rate. Since it is necessary to maintain a constant reflux ratio in precision fractionation, some means must be provided for the control of the boil-up rate. A manometer connected to the stillpot and condenser, or to the stillpot alone if distillations are made at atmospheric pressure, will indicate the pressure drop across the packing. This pressure drop can be held fairly constant by manual control of the heat input to the stillpot. Such an operation is tedious. Numerous manostatic controls have been used to control the boil-up

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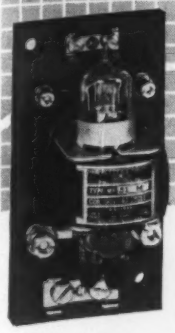

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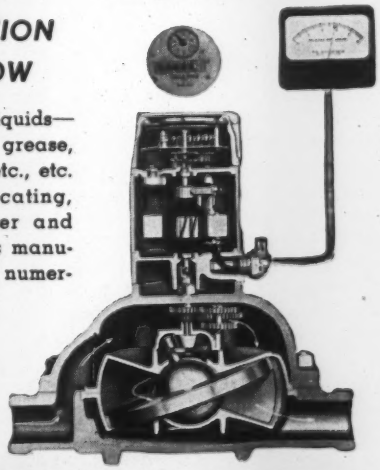

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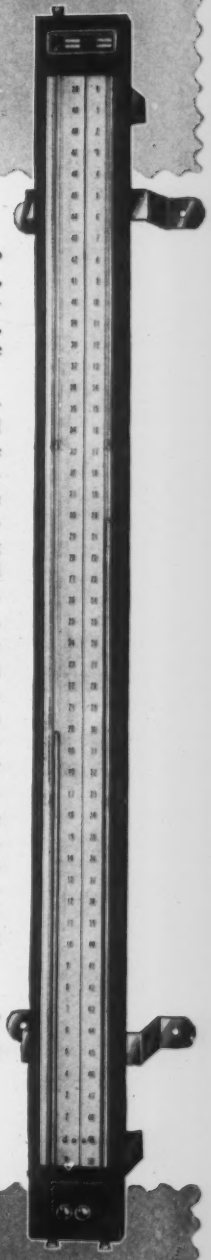

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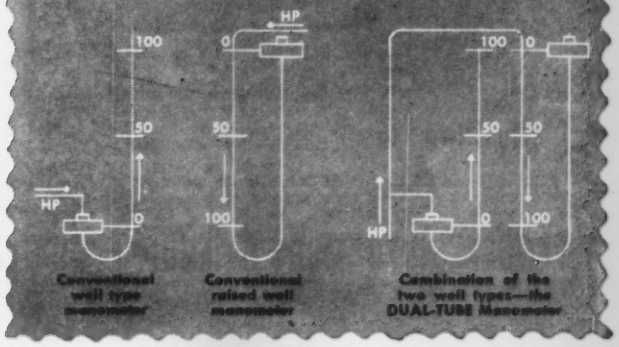

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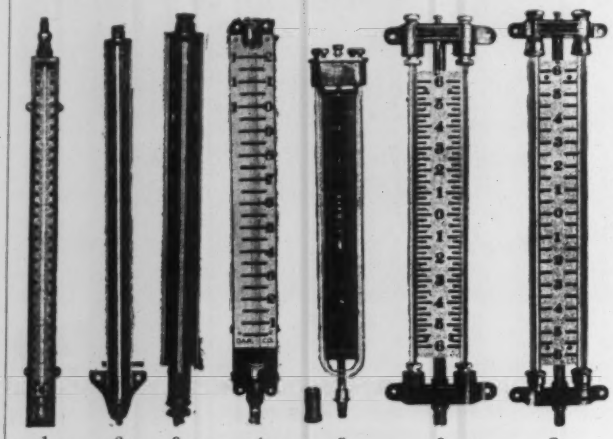

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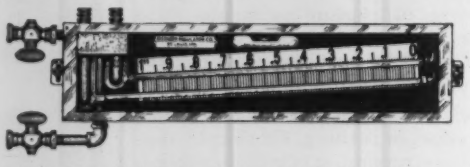

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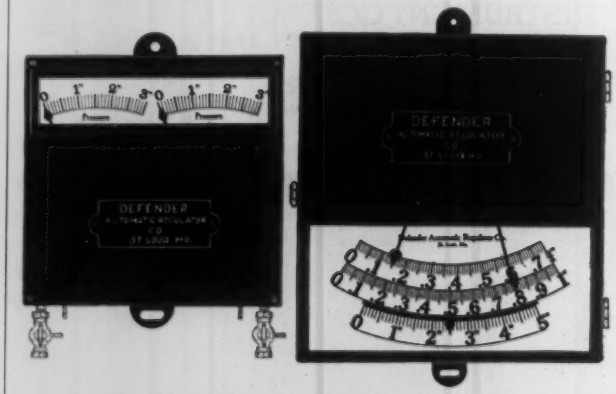

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rate.[1,2,3] One assembly which has been successfully used is shown in Fig. 189. The manometer consists of a wide and narrow leg, B, D, the former being connected to the stillpot. A short section of rubber tubing in the connecting line will increase flexibility. A light source and phototube are housed in the two tubes, C, which converge on the narrow leg. The third leg is useful for visual observation. The manometer is filled with dibutyl phthalate colored with the dye Nigrosine.

The phototube circuit need not be discussed. Numerous small and compact commercial units are available. The "Model 150" unit produced by United Cinephone Corporation is suitable. The circuit described by N. Ceaglske and S. Kesslinger[4] can also be used. Use of the "1P42" phototube produced by Radio Corporation of America makes it possible to mount the tube in a small space. This phototube is only 1¼" × ¼". Its screen is perpendicular to its axis and can thus be mounted in a small short Bakelite tube. The phototube and light source should be perfectly aligned and mounted on a single slide rod. A small thumb-screw can be used to hold the entire assembly in the desired position.

The circuit for the stillpot heater is quite simple. It is necessary to have it arranged so that a portion of the current is cut off when the boil-up rate is too high. A power source connected through the relay in the photoelectric circuit is used to supply current to the coil of a heavy-duty single-pole double-throw relay.

The heater current is obtained from the load side of a variable-voltage transformer such as a Variac or Powerstat. One of the load lines is connected to the stillpot heater. The other line is connected to the movable contact of a heavy-duty relay. The two fixed points on the relay are connected to the stillpot heater through two separate lines. One of these lines contains a resistor. When the boil-up rate is too high the phototube is cut off from the light source. The relay in the phototube circuit is energized, which in turn energizes the heater relay. The heater current is then cut down because of the resistor. This will cause a drop in the boil-up rate which in turn gives a decrease in the pressure drop. The phototube is energized by the light source when the pressure drop decreases and the heater relay is de-energized. A greater current is then supplied to the stillpot heater. This current is adjusted by the Variac or Powerstat to give a boil-up rate which is just slightly greater than the required rate.

A second method of controlling the pressure drop in fractionating columns operated at atmospheric pressure is the use of an open-end manometer. This manometer has a wide leg and a narrow leg which is open to the atmosphere. The manometer is charged with diethylene glycol colored by the dye Negrosine. A small amount of sodium nitrate is dissolved in the diethylene glycol to increase the electrical conductance of this manometer fluid. Two insulated probes are used in the narrow leg for the actuating contacts for an electronic relay which controls a heater exactly as described for the phototube assembly. Commercial electronic relays are available. The General Electric relay "CR7511-A111" is satisfactory. The conductance of the diethylene glycol-sodium nitrite mixture is sufficient to operate the electronic relay. One of the probes is set about 1/16" below the other at the desired pressure drop level. The control level is between the two probes. When the pressure rises to the top probe, the heater current to the stillpot is cut down to give a lower boil-up rate and when the manometer fluid level is below the top probe, the heater current is sufficient to give a higher boil-up rate.

To be continued

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4. N. H. Ceaglske and S. Kesslinger, *Industrial and Engineering Chemistry, Analytical Edition*, Vol. 16, 1944, page 393

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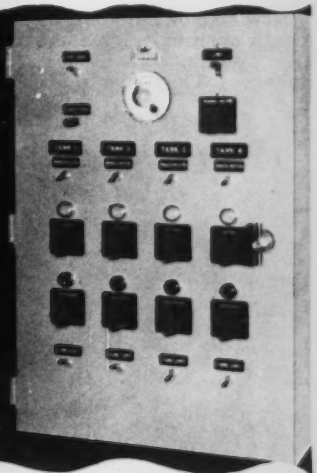

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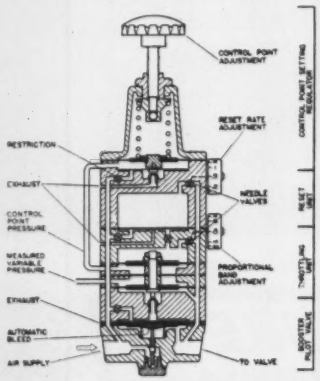

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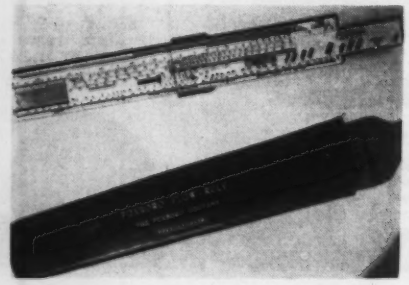
Flow-rate Calculator

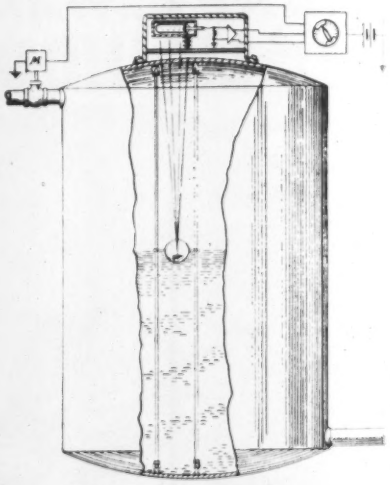
New 12" "Flow Rule" for computing orifice plate bores, flow nozzles or Venturi throats, and also flow-rate or differential across orifice plate (whether flange-tapped or full-flow-tapped) or other primary device, can be used for all fluids, with or without seals. It covers such a wide range of flows and line sizes that it will handle almost any commercial problem. Not intended to replace computation methods where purchase and sale of fluids are involved, it will be found to be invaluable for checking such calculations: its accuracy being closer than can be read without a magnifying glass. All necessary instructions are on back. Reversible slide has scales for gas on one side and liquids and steam on other side. Use of color to distinguish scales for such fluids adds to convenience. Other color bands are shown, with tick marks indicating I.D. of Schedule 30, 40, 80 and 120 pipe.—*Book Dep't, The Foxboro Co., Foxboro, Mass.*



Please mention number 1003 when filling out card

Connectionless Liquid-level Control System

New "Gagetron" utilizes a gamma-ray detector and a small radium source to determine liquid level without any connection originating inside containing vessel. Thus it solves problem presented where, owing to nature of liquid, conventional float, electric contact, pressure differential, gage glass and even tell-tale line methods are inadequate. For example, corrosive liquids such as hydrofluoric acid are difficult to hold in a container; addition of openings in vessel wall further complicates problem. Instrument containing counter-type gamma-ray detector is placed on exterior of vessel; gamma-ray source (iridium-platinum needle containing a minute quantity of radium salt) is placed inside a corrosion-resistant float directly below detector. As gamma-ray absorption factor of vessel wall directly below detector is a constant, and as absorption factor of air, gas or vapor above liquid is negligible, amount of detected gamma radiation (and hence detector pulse rate) is inversely proportional to square of distance between source and detector. Pulses are amplified, integrated and

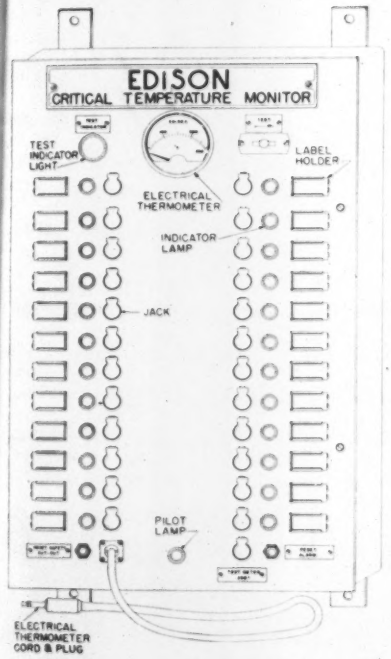


rectified to produce a direct current proportional to pulse rate. Since this d.c. is inversely proportional to square of distance, measured level at extremes would be difficult to read; to overcome this difficulty a feedback circuit produces a d-c. value approximating linear relation to distance between source and detector: readily convertible into liquid level expressed as feet and inches. Instrument operates on 90-110-volt 50-60-cycle a-c. source; consumes approx. 75 watts. Combination of "Gagetron" with Brown "Electronik" recording controller permits recording and automatically controlling liquid level.—*Engineering Laboratories Inc., 624 East Fourth St., Tulsa 3, Okla.*

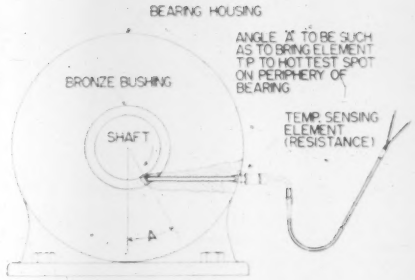
Please mention number 1004 when filling out card

Bearing-temperature-monitoring System

New multi-point bearing temperature monitoring system with automatic features is adapted both to principal equipment and auxiliaries. As many as twenty-four bearings can be monitored from each central cabinet. Electrical-resistance bulbs (0.215" diameter) are mounted in small holes drilled in bearings. Temperature-sensitive bulb tips being in direct contact with bearing metal close to inner bearing surfaces, bearing temperatures fluctuations are sensed rapidly. Temperature of each bearing is checked automatically every two minutes. If it exceeds an established maximum (which may be different for each bearing), an alarm is sounded to call an attendant: overheated bearing is identified by an indicating lamp on central panel. A modification of system not only sounds an alarm at one established temperature, but also automatically shuts down the machine if a second (higher) established temperature is reached. This is particularly useful at unattended substations or pumping stations. With modified system, initial alarm can be transmitted to a central point any distance away so that an attendant may be sent to take corrective action and prevent a shut-down if he arrives before a dangerous temperature is reached. In either system, checks of all temperatures may be made any time at central panel, on which facilities are also provided for checking and testing all circuits and alarms.—*Instrument Div., Thomas A. Edison, Inc., West Orange, N. J.*

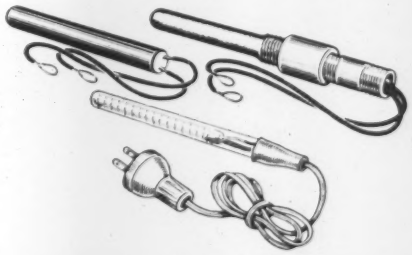


Please mention number 1005 when filling out card


BEARING HOUSING
ANGLE "A" TO BE SUCH AS TO BRING ELEMENT TIP TO HOT TEST SPOT ON PERIPHERY OF BEARING
BRONZE BUSHING
SHAFT
TEMP. SENSING ELEMENT (RESISTANCE)
A

Electric Heaters

New "Thermolettor" metal-clad electric heaters are derived from an all-glass unit inserted into steel tubing and space between filled with a special alloy. New units are suitable for bath temperatures up to 600°F. For use in melting pots for type metal, etc., a direct-immersion unit is available: at least 1/16" thick of metal is deposited directly on glass. These units are available in heavy chrome-plated copper, bare copper, aluminum, stainless steel, etc., can be used up to 1100°F. All units provide a solid path for heat from wire to outside. Therefore, heat transfer is excellent. About 80 watts /in.^{2} can be counted on.—*Thermolettor Products, 95 Broad St., New York 4, N. Y.*



Please mention number 1006 when filling out card

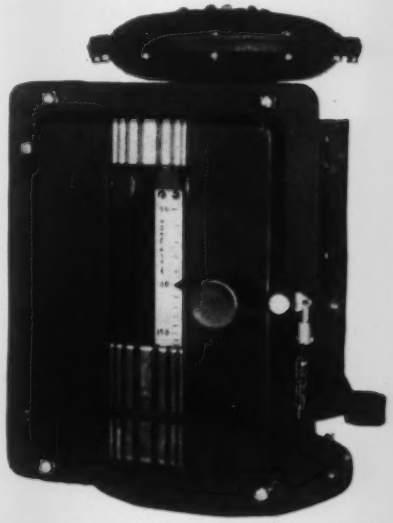
Pyrometric and Electrical Indicating Instruments

New "Veri-Tell Series" of precision electrical indicators has been added to maker's line of automatic electronic control equipment. "Model I" is a millivoltmeter pyrometric indicator thermally compensated, and including Bréguet (thermostatic) automatic cold junction correction. "Model H" millivoltmeter pyrometric indicator is said to establish a higher level of measurement accuracy than has hitherto been available, by replacing conventional Bréguet cold junction compensation with newly-delevoped "Hypar" compensator which derives its operative energy from line supply. Fully compensated for all instrument errors, these devices are said to be especially useful in sensitive chemical processes, laboratory measurement, thermal analysis problems, and applications where unusually narrow or negative, scale ranges are required. For specialized applications, hand-drawn scales are available. Construction embodies a precision instrument assembly method, in which pole-pieces, magnets, core assemblies, moving systems are rigidly aligned and permanently fastened by maker's "Kool-Weld" process. This method is said to insure rigid vibration-proof structure, long life, creep-proof calibrations and precise production uniformity. It is said that late developments in magnet alloys, pivots and jewels allow systems to exhibit unusually high sensitivity, high torque, and dependability. Full 5" scale, anti-parallax mirror, and targeted knife-edge pointer are standard. Universal flush or surface mount case is standard, with maker's plug-in design. New "Veri-Tell" instruments are also available for voltmeter, ammeter, wattmeter, and ohmeter use. Designs are available for specialized purposes, and full accessory equipment is available.—*Taco West Corp., 2620 S. Park Avenue, Chicago 16, Ill.*

Please mention number 1007 when filling out card

Air-fuel Ratio Controller

New "Air-Fuel Ratio Controller" which completes maker's temperature and combustion control systems for large industrial furnaces has features of simplicity, accuracy and sensitivity. Like maker's "Micromax" pyrometers and furnace pressure controllers with which it operates, this controller employs electric-motored valve drives, needs no hydraulic piping. It is a balance-type instrument having ample flexibility to meet any operating condition. Its ratio can easily be adjusted manually for operation with fuels of various Btu. content. As fuel flow changes, instrument maintains air-fuel

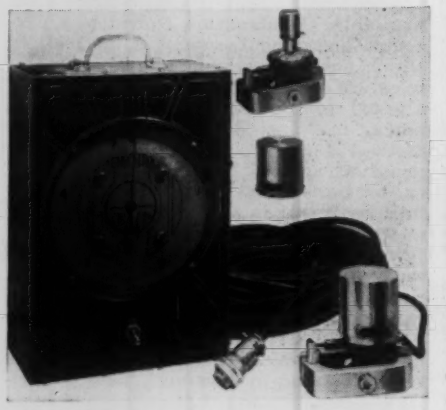


ratio constant at desired control point. Or it can provide automatic variation of ratio, increasing or decreasing percent of air at reduced fuel flows.—*Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia 44, Pa.*

Please mention number 1008 when filling out card

Mechanical Pressure Telemetering System

New "Remote Indication Pressure Gauge and Repeater Station" indicates mechanical pressure, tension, etc., utilizing maker's mechanical pressure gage

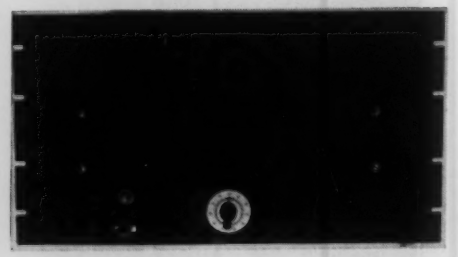


and self-synchronous motors. Repeater station instantly duplicates readings up to distances of 300 feet. Six ranges are supplied: 0-100-lb. model, 3⅝" × 4" × 1¾"; 0-250, 0-500, 0-1000-lb. models all 4 5/16" × 4" × 2 5/16"; 0-2500, 0-5000-lb. models, 4⅝" × 4" × 2¾". Weights from 2¼ to 3½ lbs. Repeater station cabinets: 8" × 11½" × 4½" with 6½" dial. Cabinet contains two 6-volt dry batteries and weighs 9½ lbs. System operates on 12 volts, d.c. Transmitter pressure gage furnished complete with repeater station, aircraft socket connectors and two dry batteries.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Ill.*

Please mention number 1009 when filling out card

High-precision Temperature Controller

New "Proportioning Electronic Temperature Controller" is said to maintain temperature of electrically-heated ovens within less than 1/10°F. at tem-

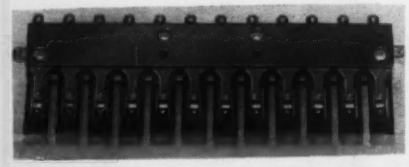


peratures up to 1200°F. Rapid achievement of temperature is accomplished because instrument does not throttle power until furnace reaches a point within 15°F. of desired temperature. Accurate selection of temperature is made by means of a large vernier type dial. Controller operates on 110 volts a.c.; can be used with furnaces requiring 110 volts or 220 volts a.c. Unit measures 19" wide × 10½" × 10½" and can readily be adapted to particular installations.—*The W. S. Macdonald Co., 33 University Road, Cambridge 38, Mass.*

Please mention number 1010 when filling out card

Gang Limit-switch

New "12 Gang Open Blade Switch" incorporates maker's "Rolling Spring" principle. Available with normally-open, normally-closed or double-throw circuit on any pole or combination of poles; engineered for cam or plunger operation. Center blade and rolling spring both of heat-treated beryllium copper; all other parts cadmium-plated. Over-all dimensions: 5⅞" × 2 1/16" × ½". Rated at 10 amps, 125

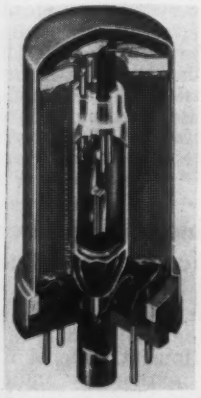


volts a.c. Operating force 4½ to 6 oz. Maximum movement differential 1/16". Minimum overtravel 1/16". Minimum release force 2½ oz. Also available in other multiple arrangements.—*The Acro Electric Co., 1324 Superior Avenue, Cleveland 14, Ohio.*

Please mention number 1011 when filling out card

Mercury-contact Relays

New "275 Type" and "276 Type" relays, for high-speed switching operations under adverse atmospheric conditions, feature small size, high sensitivity, and constancy of operating characteristics; have a conservative life expectancy of $>10^9$ operations when operated within their ratings. Repetitive precision with which a given

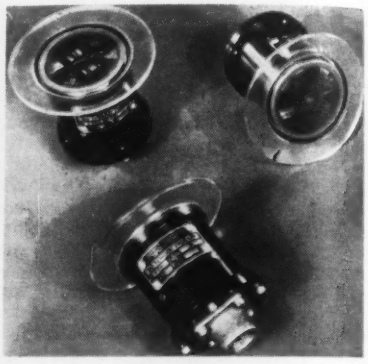


relay may be expected to operate is within 1% of its minimum operating current. Novel use of mercury wetted contact surfaces in hermetically-sealed switch associated with the relay is said to give a number of advantages over previous types of switches: almost instantaneous break of contacts with consequently high current-handling capacity; mercury provides extremely low contact resistance, serves to dampen undesirable modes of vibration, and completely eliminates chatter. Continuous replenishment of contact surfaces prevents deterioration of underlying metal. Switch unit is sealed in a gas-filled glass envelope, requires no maintenance, is free from effects of moisture, dirt, corrosion and atmospheric pressure.—*Western Electric Co., 195 Broadway, New York 7, N. Y.*

Please mention number 1012 when filling out card

Dragless Pointer-position Transmitter

New "No Torque Instrument Pick-up" transmits indication of practically any type of aircraft or industrial instrument, does not affect accuracy of instrument being read. Unit converts

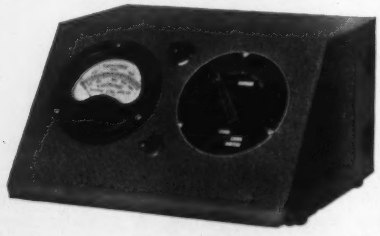


pointer position into an electrical phase angle. Accuracy of indication is within a few degrees, depending upon associated equipment. Installed, it replaces glass window on instrument. A small permanent magnet is then mounted on spindle whose position is to be read. There is no mechanical connection between pick-up and instrument, and there are no moving parts in pick-up itself.—*Engine Control Div., Fairchild Camera & Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.*

Please mention number 1013 when filling out card

Temperature Controller and Indicator

New "Series 500" stepless-input controller and temperature indicator complements "TEMCO" line of electric furnaces; is made for use with various makes of electric furnaces, ovens, melting pots, heating tanks, etc. Thermostatic switch is controlled by a knob which can be set to regulate current input from 5%-ON-95%-OFF time cycle to 100% ON. New instrument automa-

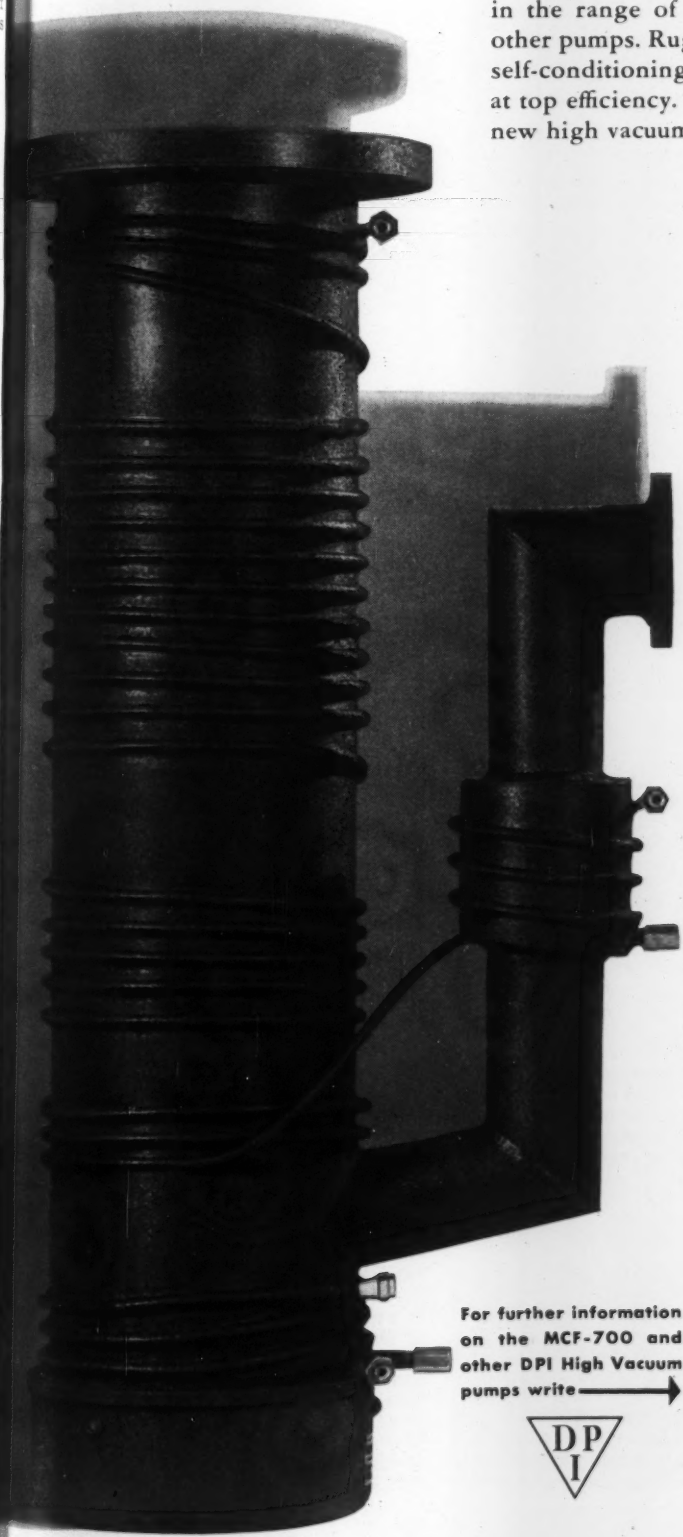


tically compensates for changes in line voltage and will maintain a constant watthour input and even temperature regardless of wide voltage fluctuations. Moreover, only 5 to 20 watthours are required to operate controller, leaving nearly all of power to be consumed in useful load. Indicating pyrometer is calibrated in both F. and C. scales to 2000°F. and 1100°C. A 4-foot color-

For New High Speeds in the Lower Pressure Ranges—

THE MCF-700 HIGH VACUUM PUMP

WHEN you need high pumping speeds in pressures down to 10^{-6} mm of mercury, the performance of the new MCF-700 will meet your specifications exactly. This pump delivers from 100 to 500 liters per second in the range of 10^{-6} to 10^{-5} mm, — performance unduplicated by any other pumps. Ruggedly constructed, the MCF-700 operates on a unique, self-conditioning principle which keeps the fractionating jets operating at top efficiency. The tables below outline the essential features of this new high vacuum pump.



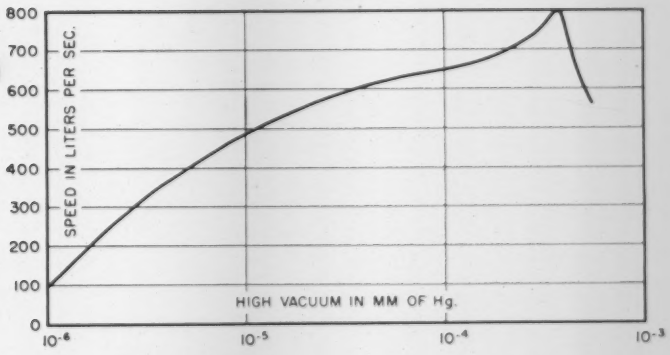
PHYSICAL DATA

High Vacuum Flange	6″ i.d., 9″ o.d. 8″ bolt circle
Forepump Flange	2⅜″ i.d., 3¾″ o.d. 3 5/16″ bolt circle
Height	29″
Length	14″
Width	9″
Construction:	
Casing	Seamless Steel
Jet Assembly	Aluminum and Steel
Cooling	Water
Weight	Approx. 40 lbs.

OPERATION DATA

Amount of Oil	500 grams
Recommended Oil	Octoil or Octoil-S
Forepressure	0.10 mm
Heater Power	800 watts
Heater Current	7.0 amp.
Heater Voltage	115 volts A.C. or D.C.
Speed	700 l/s
Ultimate Vacuum	5 x 10^{-7} at 25° C.

PERFORMANCE



For further information on the MCF-700 and other DPI High Vacuum pumps write ⟶

DPI

Vacuum Equipment Division

DISTILLATION PRODUCTS, INC.

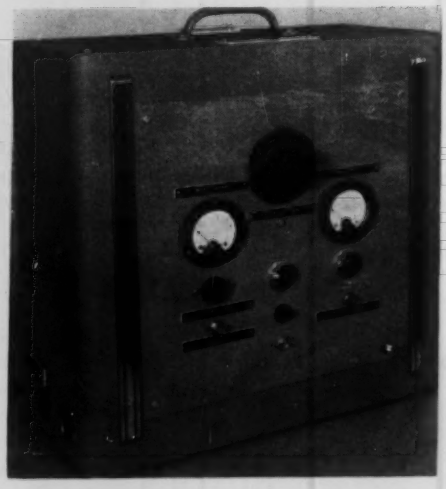
Rochester 13, N. Y.

coded thermocouple of 14 gage chromel-alumel is supplied. Panel also houses a toggle switch and neon pilot light. Welded steel case is 9″ wide, 5″ high and 8″ deep; the weight is 6 lbs. Rubber feet and a metal bracket are both supplied for either desk or wall mounting. Eight models are available, covering current requirements of 115 and 230 volts, 10 to 35 amperes, 25 and 50/60 cycles a.c. and for d.c.—*Thermo Electric Mfg. Co., 480 West Locust Street, Dubuque, Iowa.*

Please mention number 1014 when filling out card

30-kv. D-c. Power Supply

New "Model 201 Portable Power Supply" provides smoothly-adjustable voltage from 0 to 30 kv. at low currents. Maximum load current at 30 kv. is 300 microamperes, dropping off to about 23 kv. at 1.5 milliamperes. Currents up to 2 milliamperes may be drawn. Output ripple at 30 kv., <2%. New circuit components and design are

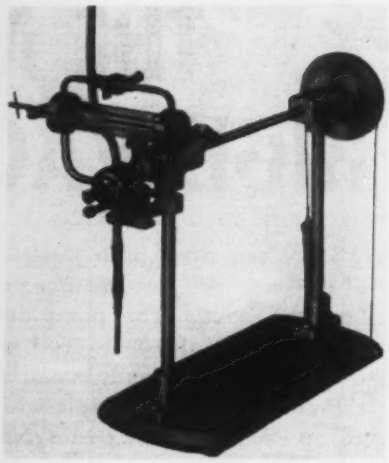


integrated to produce this rectified 60-cycle power supply in a portable cabinet 16″ × 16″ × 8″. Approx. 200 va. are drawn from 115-volt 60-cycle line at maximum output voltage. Included in equipment: output kilovoltmeter, "Variac," current meter, filament and power-on indicating lamps, and relay switching circuits for permitting either manual or automatic "high-voltage-on" control. A current-limiting resistor in output circuit limits surge current to a safe value, in case of flashover of load. Sustained short-circuit current is limited to a safe value by inherent circuit regulation. New power supply finds applications in television work, cathode-ray oscillography, flash photography, electronic precipitation, high-voltage insulation testing, etc.—*Beta Electronics Co., 1762 Third Avenue, New York 29, N. Y.*

Please mention number 1015 when filling out card

Laboratory Vessel-filling Machine

New improved model of "Gemware Aseptic Filling Machine," though originally designed for precision aseptic filling of pharmaceutics, finds application in industrial and research laboratories where workers regularly mix liquids. It not only saves time but can be set to deliver to close limitations, as



low as 0.1 cc. Four sizes: ¼ to 6cc. or over; 2 to 25cc. or over; 5 to 60cc. or over; 9 to 100cc. or over. Regular machines are foot-treadle operated; hand-operated models can be supplied; also motorized units; as well as multiple filling units, motorized type, with automatic conveyors. They are made of pure nickel but stainless steel models can be supplied.—*G. M. Mfg. Co., 50 West Third St., New York 12, N. Y.*

Please mention number 1016 when filling out card

Reflected R-f. Energy Indicator

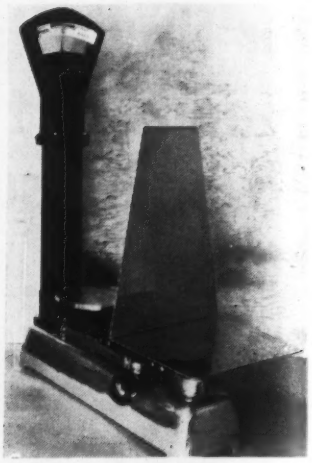
New "Mega-Match" is described as a "completely electronic basic laboratory instrument for measuring reflected energy." It measures reflected energy

over frequency band of 10 to 250 Mc. and up; it presents a visual display of reflected energy over any band up to 30 Mc. This visual display eliminates tedious tabulation work, saves many hours of engineering time. New instrument makes it possible to instantly observe and measure mismatches. There are no slotted lines, moving parts, directional couplers, or other frequency-sensitive devices. A precision frequency meter is incorporated in unit. — *Kay Electric Co., 34 Marshall St., Newark 2, N. J.*

Please mention number 1017 when filling out card

Heavy-duty Scale

New "Detecto-Gram Aluminum Speed Scale," a heavy-duty model designed to speed up packing and processing operations, has a capacity of 20-30 lbs. and ¼ oz. precision with beam graduations reading up to 1 lb. Commodity plate is 8″ × 10″ × 14″. Time-saving air-con-

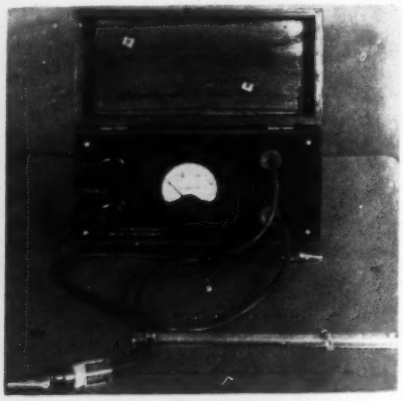


trolled dashpot minimizes fall of scale lever when a package is placed on commodity plate. Extra-high pillar towers "Over-and-Under Head" well over height of commodity plate, enabling operator to read indicator at a glance, no matter how high packages are.—*Detecto Scales Inc., 1 Main St., Brooklyn 1, N. Y.*

Please mention number 1018 when filling out card

Kilovoltmeters

New "Series 101 Kilovoltmeters," for measuring high d-c. voltages at a full-scale drain of only 20 microamperes, are available in ranges up to 50 kv.



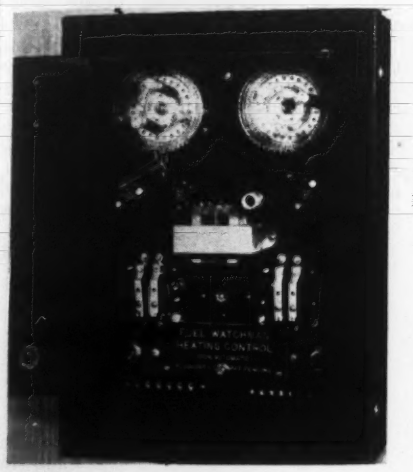
full-scale. All are 50,000 ohms/volt single-range voltmeters, so that polyethylene-insulated leads are permanently connected to impregnated voltage multiplier inside case, assuring complete safety when in use since there are no exposed metal parts at high voltage on panel. Only exposed metal is at ends of leads, where contact is actually made to high-voltage circuit under test.) A 10″ polystyrene handle, which permits measurements to be made safely on "live" high-voltage circuits, is a time-saving feature in many types of experimental work. A new technique of mounting and impregnating multiplier resistor is said to result in great stability although resistance is of the order of thousands of megohms. Seasonal variations of atmospheric conditions result in a calibration variation of about 1%. Initial calibration is closer than 2% of full-scale value, so that guaranteed accuracy of each instrument is 3% of full-scale reading. Oak case is 11″ × 5″ × 7″, with a

black engraved Bakelite panel. A polarity reversing switch is provided, as is a "Transit" switch to short out the 20-microampere movement when an instrument is being transported. Owing to extremely low drain, new instruments are of particular value in television work; also electrostatic precipitation measurements, Geiger-Mueller power supply measurements, x-ray tube voltage measurements, etc.—*Beta Electronics Co., 1762 Third Ave., New York 29, N. Y.*

Please mention number 1019 when filling out card

Building Temperature Control System

New "Fuel Watchman" is a fully-automatic system for controlling temperature of a building, such as an apartment house, without the use of room thermostats. Neither open windows nor local sources of heat (ranges, etc.) can affect its performance. It supplies heat as needed according to out-



side conditions. It serves equally well on central or zone control systems, controlling steam, hot water, oil burners, stokers or gas burners. It can control air-conditioning unit in summer and heat supply in winter. Once installed and adjusted for particular building, "Fuel Watchman" takes care of nightly and seasonal start-up without attention, by program clocks whose schedules depend on outside conditions. System consists essentially of (1) Roof control, (2) North side control, (3) Main control panel. Roof control is located where it receives direct rays from sun for greatest length of time. Its purpose is to determine amount and effect of solar radiation absorbed by building and prevent overheating on mild days. North side control (protected from sun) is adjusted at factory for operations over different temperature ranges. Main control panel features two Telechron synchronous motor clocks, on which are mounted six schedule disks. Each disk corresponds to one outside-temperature condition so that there will be only one schedule in operation. Each clock-driven disk is notched to close and open control circuit at proper intervals throughout the day. While control circuit is closed, burner or stoker or pump operation is controlled by steam pressure switch. Morning start-up notches keep control

CURRENTLY FROM SORENSEN AT STAMFORD

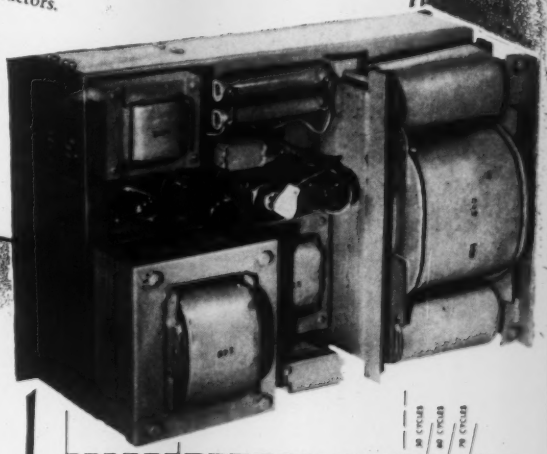
SORENSEN & COMPANY, INC.
Manufacturers of
VOLTAGE REGULATORS, NOBATRONS & ELECTRONIC APPARATUS

SORENSEN & COMPANY

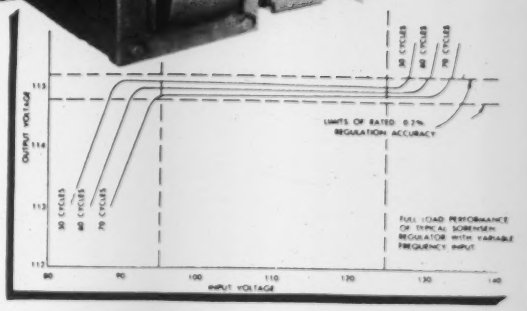
RUNAWAY VOLTAGES STOPPED AT 1/10 OF 1%

Rated performance of Model 1750-S *guarantees* delivery of output line voltages at a regulation accuracy of 0.2% under varying load. However, in *actual tests* of this unit voltage stabilization was held to within 0.1% under full operating conditions. This conservative safety rating of 0.2% is typical of all Sorensen performance factors.

Input voltage range	95-125
Adjustable output between	110-120
Load range	200-2000 VA
Regulation accuracy	0.2%
Harmonic distortion	2% max.
Recovery time	6 cycles
Input frequency range	55-65 cycles



IT IS "A NATURAL" FOR CONTROLLING VOLTAGES IN LABORATORIES, ASSEMBLY LINE TESTING AND AS A COMPONENT OF YOUR ELECTRICAL UNIT.


OUTPUT VOLTAGE
INPUT VOLTAGE
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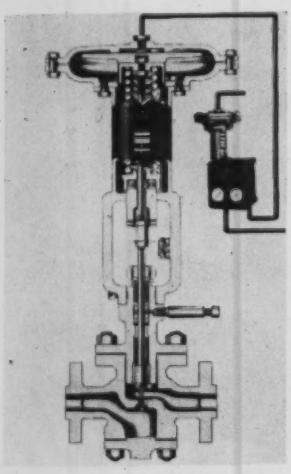
circuit closed until building is warmed, after which operation is intermittent. Morning start-up and night shut-down are automatically advanced or delayed to correspond to outside temperature. Announcement states that "continuous operation for five years in various types of buildings having different kind of heating systems has given complete satisfaction to the owner," but that this is first public announcement of system and that it is guaranteed for three years.—*Fuel Watchman Co., 77-29 138th St., Flushing, N. Y.*

Please mention number 1020 when filling out card

Diaphragm-motor Valves

New "Class DL" and "Class DLS" Diaphragm Regulating Valves with "Conden-Seal" cooling bonnet for use with air or water operated Controllers, have new features which include: Single-seated tight-closing main valves; Hardened stainless steel valves, stems and guides, and integral hard-surfaced seats; Valve-above-seat position for reverse- or direct-acting valves; Easy reversal of valve action by a

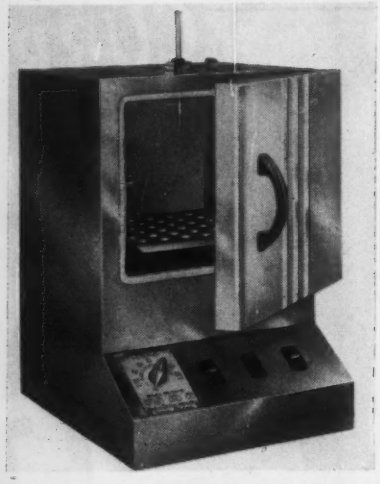


simple change of diaphragm superstructure; "Conden-Seal" cooling bonnet which includes a stainless steel radiating tube and a condensate reservoir for steam service to protect low-friction packing gland at temperatures above 450°F.; Sensitive diaphragm assembly which maintains constant effective area throughout travel. "Class DL" is available in semi-steel (125-lb. flanges) or bronze body (300-lb. flanges); "Class DLS" in cast steel (600-lb. flanges). Suitable for steam pressures up to 600 lbs. and temperatures up to 800°F. and for pressure drop across main valve as high as 300 lbs. in smaller sizes.—*Leslie Co., 225 Delafield Ave., Lyndhurst, N. J.*

Please mention number 1021 when filling out card

Laboratory Oven

New "Model OV-8," said to be probably the smallest electric laboratory oven on the market, has inside dimensions of 8" × 8" × 8" and a temperature range of 100°F. (37.8°C.) to 400°F. (204.5°C.). Underwriters-approved hydraulic thermostat has response sensitivity of 0.5°C. Special "engineered Therm-O-Flake insulation" minimizes heat loss and highly-polished

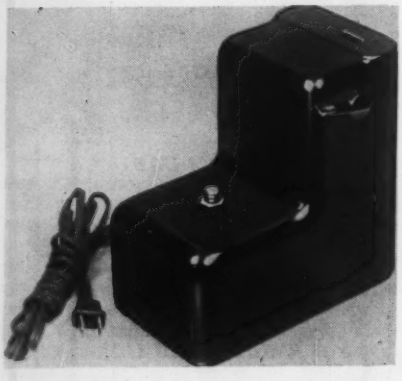


stainless-steel interior provides maximum heat reflectance assuring uniform temperature. Red neon light signals unit operation; green signals thermostat operation. Intake and exhaust ports (latter adjustable) permit any desired amount of air circulation. New oven is available in two models, operating on a.c. and d.c. respectively. An automatic timer is available as extra equipment. — *Modern Electric Laboratory, 6131 S. Wentworth Ave., Chicago 21, Ill.*

Please mention number 1022 when filling out card

Number Marker for Films

New "Foto-Marker" is a device for printing identifying numbers on photographic materials. Film, plate or printing paper is placed over a ¼" × 1" aperture in top of unit. A switch is closed, projecting the figures of a mechanical counter onto emulsion. Thus, when emulsion is developed, serial number of exposure appears as white numerals centered on a dark background



approx. ¼" × 1". Mechanical counter is reversible; has a range of 00000 to 99999; can be advanced one digit between exposures. Housing is finished in bright red enamel so that "Foto-Marker" will be seen easily under dark-room safelite. Unit operates on 115-volt a.c. or d.c.; power requirement is virtually zero, for 6-watt lamp lights only momentarily. Applications: spectrograms, metallographic plates, physical-test sequences, airplane-test sequences, etc.—*Millen Mfg. Division, P.O. Box 3911, Detroit 27, Mich.*

Please mention number 1023 when filling out card

Laboratory Oven

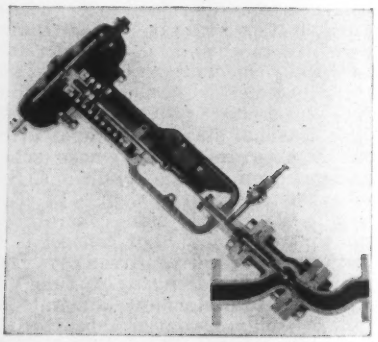
New "Mechanical Convecti[on]" drying oven has provision for co[n]veying heated air across working c[h]amber. Air volume, air circulation and [h]eat in-

tensity are said to be accurately controlled and to result in uniform automatic temperature over entire range whether oven is empty or fully loaded. Viewing window glass is heat-resisting and each pane can be removed in case of breakage. No inner door is necessary. Angle type mercury thermometer is built into front of cabinet. Oven is shipped ready for immediate operation, requires only connections to power line, is available in three sizes from 3 to 9 cubic feet and two ranges, 180°C. and 260°C.—*The Electric Hotpack Co., Inc., 5029 Cottman Ave., Philadelphia 35, Pa.*

Please mention number 1024 when filling out card

Diaphragm-motor Valve with Venturi Throat

New "No. 700-V" Venturi-throat diaphragm-motor valve is specified for control of highly viscous fluids and of fluids carrying abrasive material such



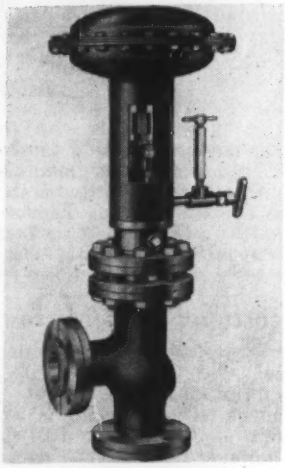
as suspended clay or other erosive agents. Streamlined Venturi design of valve and its installation in a horizontal pipe line prevent a sudden change in direction of flow, so that destructive impinging effect of solids on valve body and outlet piping is avoided. New valve is especially recommended for high fluid velocities. It can be furnished with a flushing connection through which high-pressure fluid is forced to keep stem tolerances clear. Other accessories available are handwheel operators, decoking devices, positioners and radiation fins. Venturi throat valves are supplied with standard A.S.A. ratings in

either the screwed or flanged type. Special material for body and trim are selected to meet prevailing operating conditions. Renewable disk and seat ring can be furnished with a protective layer of hard-surface material. An exclusive Belfield design feature is that valve can be converted in the field from horizontal to angle type by a simple turn of flanged outlet connector.—*H. Belfield Co., Broad St., at Hamilton, Philadelphia 23, Pa.*

Please mention number 1025 when filling out card

Diaphragm-motor Valve with Venturi Throat

New "Venturiflo Diaphragm Control Valves" with Venturi throat insuring optimum streamline flow characteristics are designed primarily for high-pressure applications. Basic design is cast bowl-type angle body which will insure no increase in flow velocity as fluid leaves piping and enters valve body. Valve body conforms to ASA face-to-center-line dimensions. Friction factor will average 5 in comparison to



9 in usual globe or double-seated control valves. Valve plug is top-guided and centered in seat both by mechanical guiding and flow of fluid through valve body. Seat is designed as a section of a Venturi throat, insures minimum turbulence and an efficiency of operation comparable to that of a Venturi throat in flow measurement. Actual capacity with full throat area will be 1½ times that of a corresponding conventional control valve. Seat is of retained type, is lapped into valve body, eliminating use of gaskets. It is retained by companion flanges on outlet piping. Construction eliminates possibility of the seat cutting out, prevents leakage between seat ring and valve body. Valve body and bonnet is provided with flushing connections, should valve be operated under coking service, on petroleum cracking applications. Flushing is also necessary for handling fluids with suspended solids which might otherwise lodge in moving parts of valve. Recirculating or warm-up body connections may be supplied if required. Where fluid temperature is above 450°C. or below 32°, maker's vertical V-fin type radiation bonnet is recommended. Motor is oversize "All-steel." If required, valve can be equipped with continuously-connected

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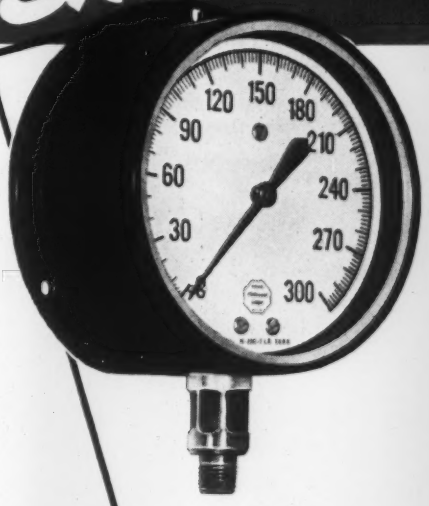

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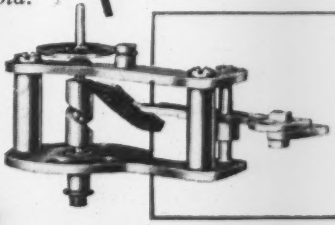

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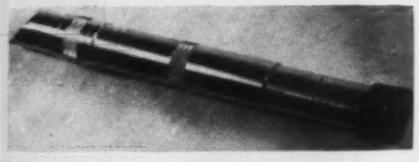
handwheel. Sizes: ½″ through 1″ screwed ends: 1″ through 8″ in flanged ends. Valve bodies are available in cast iron, bronze, cast steel, Type 304 and 316 stainless steel as standard. Valves of this sort are presently being supplied on special applications under pressures as high as 30,000 lbs./in.^{2} and working temperatures between −225°F. and 1000°F. — *Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.*

Please mention number 1026 when filling out card

Pocket Microscope

New pocket size microscope is 40-power when closed, 50 and 60 when set to markings by adjusting draw tube. Diameter ¾″; length 5″ when closed; 6¼″ when fully extended. Optical system: fully-corrected achromatic lenses. Method of using: microscope is set to desired magnification, angular end placed with polished surface towards

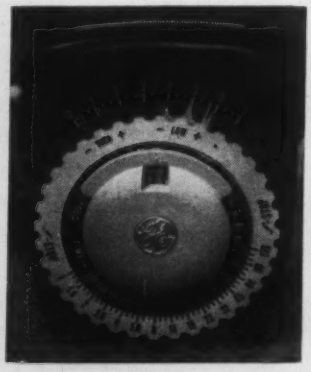


light. Held by left hand on upper knurl; fine focus obtained by turning lower knurl with right hand. New microscope is said to have all advantages of a laboratory instrument.—*Buhl Optical Co., 1009 Beechview Ave., Pittsburgh 12, Penna.*

Please mention number 1027 when filling out card

Exposure Meter

New "PR-1" photoelectric exposure meter, for amateur and professional photographers, is described as "a meter with a memory," containing a

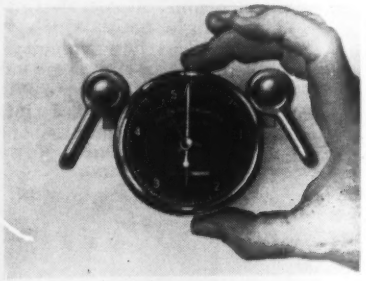


pointer-locking mechanism which "remembers" light seen by photocell. A trident analyzer is included for analyzing and studying photographic scenes to secure maximum accuracy in exposure. An automatic louver-coupled dial shifts range from dim to bright light or back again, depending upon scene requirement. Unit is magnetically-shielded, is small and thin enough to fit in a vest pocket. Sensitivity range, 0.4 to 4100 footcandles (from one small candle to brightest sunlight). Measuring accuracy is said to be "many times greater than that required for the most exacting color photography." Tight-gasketed construction keeps out moisture and dust. Incident-light-measuring attachment extends range to 61,000 footcandles. Operating direction: Press button, set trident in line with pointer, read proper exposure. Meter clearly shows a complete range of combinations of *f*-stops and shutter speeds. Unique dial construction permits movie use, with proper exposure shown for all makes of movie cameras with varying shutter angle in full range of m-p camera speeds.—*Meter & Instrument Div., General Electric Co., Schenectady 5, N. Y.*

Please mention number 1028 when filling out card

Miniature Dynamometer

New miniature dynamometer is said to be the smallest of its kind. Case diam. is 3″; weight is 1 lb. It is available in 100-lb., 250-lb. and 500-lb. capac-



ities; has an unbreakable Lucite crystal and red maximum hand. Dial is black with etched silver numerals. Components are die cast of Zamac No. 3 alloy.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Ill.*

Please mention number 1029 when filling out card

Stereoscopic Shop Microscope

New stereoscopic shop microscope has been designed to expedite industrial operations where minute details must be closely observed, is available in powers of 9×, 18× and 27×. Actually a microscope for each eye, it provides both stereoscopic vision and magnification of minute parts and details. Magnified image is seen right side up so that operations can easily be performed under instrument. Optical system with converging objectives, achromatically corrected, clearly shows length, width and depth with enhanced perspective. Microscope's two eyepieces are mounted according to normal con-

vergence of eyes for close work, are adjustable, permit use of instrument for long periods of time without eye-strain. Their design allows operator to wear safety goggles. Glass plate clipped to front of objective holder prevents oil and metal chips from damaging lens surfaces. Designed for complete flexibility, instrument can be used conventionally or bolted to a machine through a hole provided in base. It may also be attached to specially designed brackets on machines. Cabinets are supplied with all models.—*Scientific Instrument Div., American Optical Co., Box A, Buffalo 15, N. Y.*

Please mention number 1030 when filling out card

Pocket Ionization Chamber

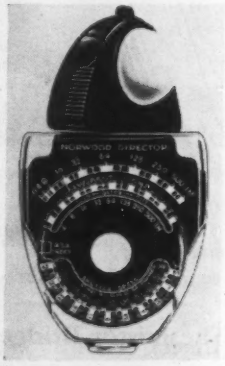
New "Model 3340" pocket ionization chamber registers radiation to which its wearer has been exposed, is constructed of gray plastic, with a spring clip. A safety cap held by friction protects metal contact point on one end. This contact point is sealed into a plas-

tic diaphragm which does not contact inner electrode until it is pressed in. This construction minimizes risk of possible accidental discharge. In severe durability tests, device has been soaked in water, thrown against wall, and dropped from various heights onto a cement floor. These tests produced only superficial scratches; even in 30-foot drop, only a slight discharge occurred. —*Instrument Development Laboratories, 223 West Erie Street, Chicago, Ill.*

Please mention number 1031 when filling out card

Exposure Meter

New "Model B" is an improved model of incident-light-measuring "Norwood Director Exposure Meter" said to have been widely used by profes-



sional color and motion-picture photographers because of its high accuracy and consistency. "Model B" has been streamlined to a hand-fitting shape; dial and calculator brought together for ease in reading. It features "Photosphere" light collector which integrates all light falling on camera side of subject. Photosphere head may be rotated to any desired angle. Light or dark backgrounds cannot cause errors in reading. "Model B" can be used with daylight or artificial light and combinations of both. Its new design also features an improved microammeter which provides added low-light sensitivity, a high-speed but steady needle,

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MEASUREMENTS
Model 59
MEGACYCLE METER

The Model 59 consists of a compact oscillator connected by a flexible cord to its power supply. The instrument is a variable frequency oscillator, an absorption wavemeter, an oscillating detector and a tuned absorption circuit detector. The engineer, technician, service man or amateur will find the Model 59 a most versatile instrument suitable for many applications.

SPECIFICATIONS:

FREQUENCY:
2.2 Mc. to 400 Mc.; seven plug-in coils.

MODULATION:
CW or 120 cycles; or external.

DIMENSIONS:
Power Unit, 5⅛" wide; 6⅛" high; 7½" deep. Oscillator Unit, 3¾" diameter; 2" deep.

POWER SUPPLY:
110-120 volts, 50-60 cycles; 20 watts.

MODEL 59 APPLICATIONS:

- For the determination of the resonant frequency of tuned circuits, antennas, transmission lines; by-pass condensers, chokes or any resonant circuit.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

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MICRO-CHANGES RECORDED ON PERMANENT RECORDS

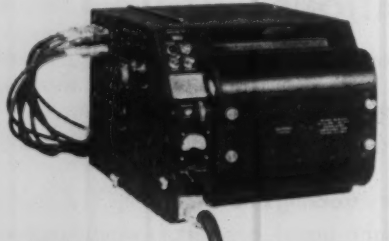
Consolidated's latest Recording Oscillograph, Type 5-115, can be used for making permanent, continuous records of static or dynamic changes from as many as thirty-six points of intelligence at the same time. This new instrument features the innovation of reduced-amplitude recording which makes it possible for all thirty-six traces to appear on paper seven inches wide. For ease of interpretation, the traces may be magnified five diameters by means of a projection viewer.

The Consolidated Type 5-114 Recording Oscillograph is of the same physical appearance but produces up to eighteen normal-amplitude traces on the same size paper.

Built sturdy and compact for the aircraft industry, these Recording Oscillographs are ideal tools for most field or laboratory research where changes in physical phenomena are measured. Full details may be had by requesting bulletin CEC-1500.

FEATURES

1–Lighter, more compact than ever!
2–Rapidly attached daylight-loading magazine.



Consolidated Type 5-115 Recording Oscillograph

3–Positive footage indicator.
4–Trace identification.
5–Complete paper-speed range from 1/4 to 50 in. per sec.
6–Automatic record-length control – for records from 2 to 55 inches.
7–Automatic numbering system – continuous or at end of each record.
8–Interchangeable galvanometers for wide range of frequencies.
9–Individual galvanometer inputs.
10–Thermostatically controlled heaters to assure constant damping for low-temperature operation.
11–Models available for either 12-v, d-c; 24-v, d-c; or 115-v, a-c power source.
12–Remote Control available – for simultaneous operation of any number of Oscillographs with common time base.

Consolidated Engineering Corporation

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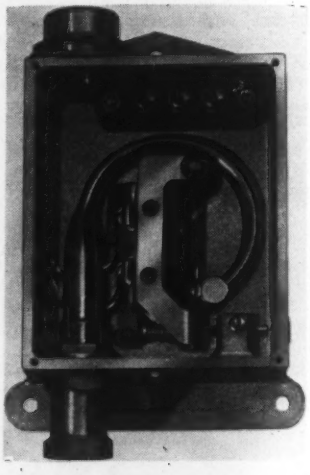
and a range of 2 to 30,000 footcandles. Cover is Plexiglass and calculator dial is mounted on it in line with needle so that readings and computation may be performed "without looking in half-a-dozen places." Dial is so designed that all calculations may be performed with same hand that holds instrument. ASA indices for film speed are used with values from 0.1 to 1000, assuring accurate computation with any make or kind of film. Film index is preset for the film in use and locks in position. Shutter speeds cover full range from 1/1200th second to 120 seconds. Shutter speed dial is also calibrated for motion picture speeds from 8 to 64 frames per second. (M-p. indications are in red.) All conventional diaphragm stops from $f/1.4$ to $f/45$ in both American and European systems of calibration are shown. "Photogrid" and "Photodisk" are available as accessories. (Professionals and advanced amateurs use them when it is desirable to measure brightness range or lighting contrast; either can be interchanged with "Photosphere" in a few seconds.) — *American Bolex Co., Inc., 521 Fifth Avenue, New York 17, N. Y.*

Please mention number **1032** when filling out card

Pressure Switch

New "Model 310" is improved version of pressure switch fully described

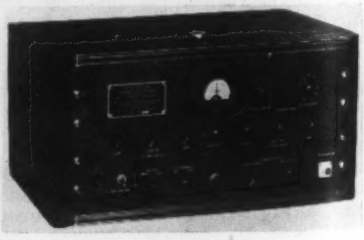


in Dec. 1946 *Instruments*, page 765.– *Melotron Corp., 950 N. Highland Ave., Los Angeles, Calif.*

Please mention number **1033** when filling out card

Thermistor Bridges

Two new thermistor bridges providing r-f. power measurement up to two milliwatts at frequencies up to the shorter microwave regions have been announced: "Type TBN-7SE" is designed for continuous duty at normal laboratory ambient temperature where

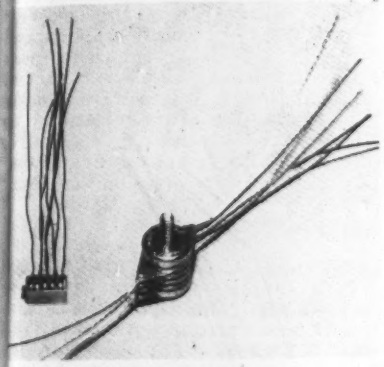


asurement in *S*, *X* and *K* microwave nds may be made accurately with table r-f. measuring heads. It is independent of frequency but should be ed with appropriate thermistor unt. It operates on 100-130-volt 60-cle supply; is rated at 25 watts; eighs 14 lbs.; measures 8″ × 8½″ × . "Type TBN-6SE" thermistor idge (illustrated) requires external en and thermistor mount, contains a heatstone bridge circuit with three ecision resistor arms and externally unted thermistor; a stabilized 2000-cle source for bridge; stable d-c. urce for substitution measurement of g. power; and an amplifier. It is independent of frequency and can be used a balanced or unbalanced bridge oviding accurate full-scale readings om 25 microwatts to 2 milliwatts. It erates on 115-volt 60-cycle supply; is ted at 150 watts (exclusive of external oven); weighs 54 lbs. (excl. of oven and thermistor mount) and measures 10¼″ × 21″ × 15″.—*Electronics Div., Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

Please mention number 1034 when filling out card

Experimental Rectifier Assembly

New four-disk instrument rectifier assembly designed for experimental use is available in 0.5″ diam., 30-mil disks as "Type X," or 0.165″ diam., 5-mil



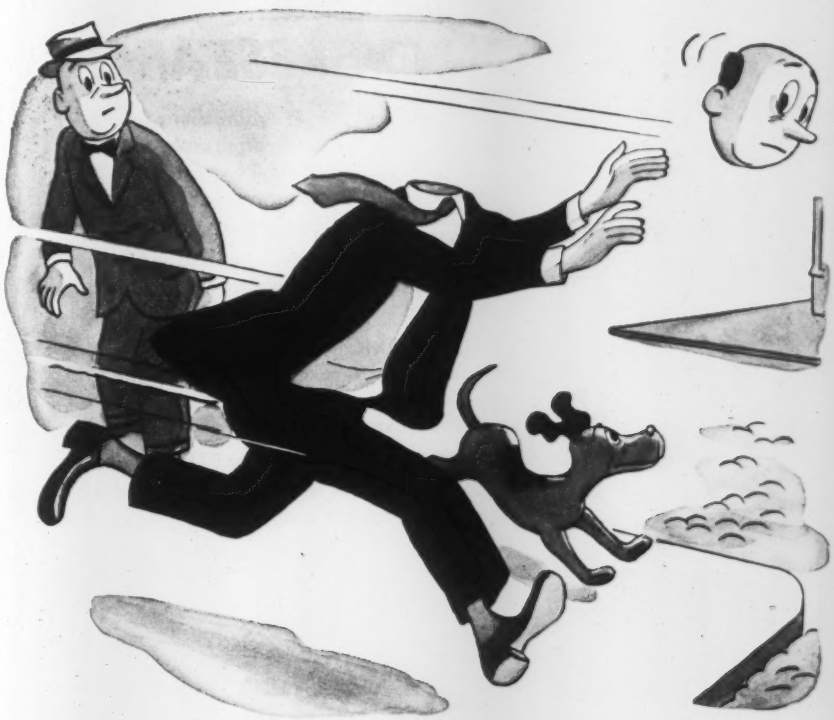
disks as "Type BX-C." Each of the four disks is insulated from the others and is provided with its own pair of leads. This construction permits connection of the four disks into any conceivable combination.—*Conant Electrical Laboratories, 6500 "O" Street, Lincoln 5, Neb.*

Please mention number 1035 when filling out card

Audio-frequency Oscillator

New "Model 200 Audio Oscillator" consists of a modified Wien bridge *RC* oscillator and a 2-stage inverse feedback output amplifier with self-con-

Don't lose your head over shortages!



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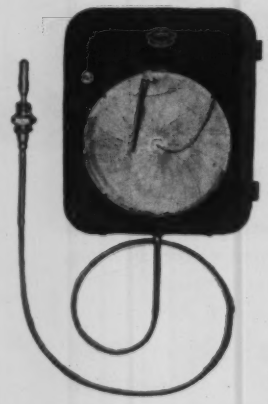
RECORDING THERMOMETERS, in aluminum cases, are supplied in 10" and 12" chart sizes, mercury actuated.

GAUGES, for standard services, are supplied in 3½", 4½", 6" and 8½" dial sizes.



Any of the following Catalogs sent on request: Glass Indicating and Industrial Thermometers No. 120; Dial and Recording Thermometers No. 320; Dial and Recording Gauges No. 520.

WEKSLER THERMOMETER CORP.
52-56 West Houston Street
NEW YORK 12, NEW YORK

THE ODOMETER
A BOON TO SURVEYORS

Enables one man to do the work of two in surveying. Saves what it costs.
Measures distance as you walk it.
Light, handy, economical.
Ball-bearing, self-lubricating. Trigger clutch, button release.

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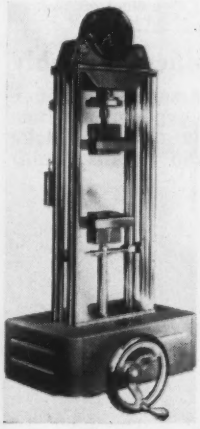
1129 BOYLSTON STREET **NEWTON UPPER FALLS 64, MASS.**

tained power supply. It is designed for distortion or frequency measurements or for any application requiring a stable, accurately-calibrated source of frequencies between 30 and 30,000 cps. Characteristics: Ranges; 30-300, 300-3000 and 3000-30,000. Voltage output 12.5 volts on open circuit, 11 volts on 500-ohm load. Wave-form: RMS harmonics <1% at 5-volt output on 500 ohm load and approx. 0.5% on >10,000 ohms on all frequencies between 50 and 15,000. Noise level 60 db below 1.5-volt output. Frequency response better than ±db on full range. Stability better than 1%. Calibration ±2.5%. Power requirement: 50 va. (110-v. 60-cps.)—*Barker & Williamson, Inc., 237 Fairfield Avenue, Upper Darby, Pa.*

Please mention number 1036 when filling out card

Testing Machine

New "1947 Hercules Model L" physical tester has 13" spread between grips. A keyless power screw, prevented from turning by means of a ball bearing-held yoke, permits smooth operation, adds to life of main drive gear. Other features are hardened steel sleeve to guide power screw, cast aluminum gear housing, ball-bearing power shaft supports, and an improved shock absorber screw. Grips are quickly interchanged to handle tensile, transverse, compression, or shear tests. "Model L" is available in ranges; 0-25, 0-500, 0-1,000, 0-2,500, 0-7,500 and 0-10,000 lbs. It is supplied complete with gripping jaws and gage. Operation is manual, with motorization optional.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Ill.*



Please mention number 1037 when filling out card

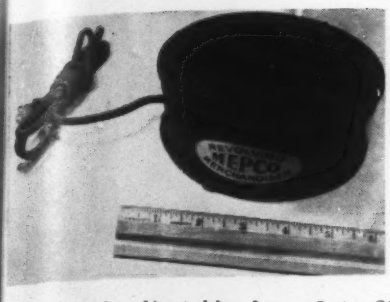
Crystal Oscillator

New "Type BH6" VHF crystal unit for 15-100-Mc. range employs a paper-thin quartz plate operating on third, fifth, and seventh overtones. Crystal, lapped as thin as 0.004", is processed to microtolerances and silver-plated to insure long-term precision. A pair of ceramic rings clamp quartz plate rigidly in position. Recommendations covering oscillator circuits best suited for optimum performance will be made by manufacturer when qualifications are stated, such as drive requirements to the following stage frequency tolerance, and temperature range over which tolerance must be maintained.—*Bliley Electric Co., 200 Union Station Bldg., Erie, Penna.*

Please mention number 1038 when filling out card

Low-speed Motor

New "Magnarotor" is a magnetic impulse motor available in a-c. or d-c. models, which rotates in either direction or is reversible. 6" diameter, 3"

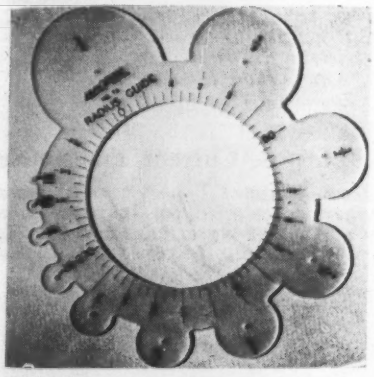


high; speed adjustable from 2 to 20 r.p.m.; can be used for any application for operating instruments, etc., where low speed is desired without use of gears and high-speed shaft. Motor requires no oiling or attention; is said to be the result of twenty years' development; can be built to special order for various applications and various power requirements. — *Madison Electrical Products Div., John G. Ruckelhaus Co., Madison, N. J.*

Please mention number 1039 when filling out card

Draftsman's Center-finding Instrument

New "Radius Guide No. 75," for quick and easy delineation of radii, eliminates time-consuming trial-and-

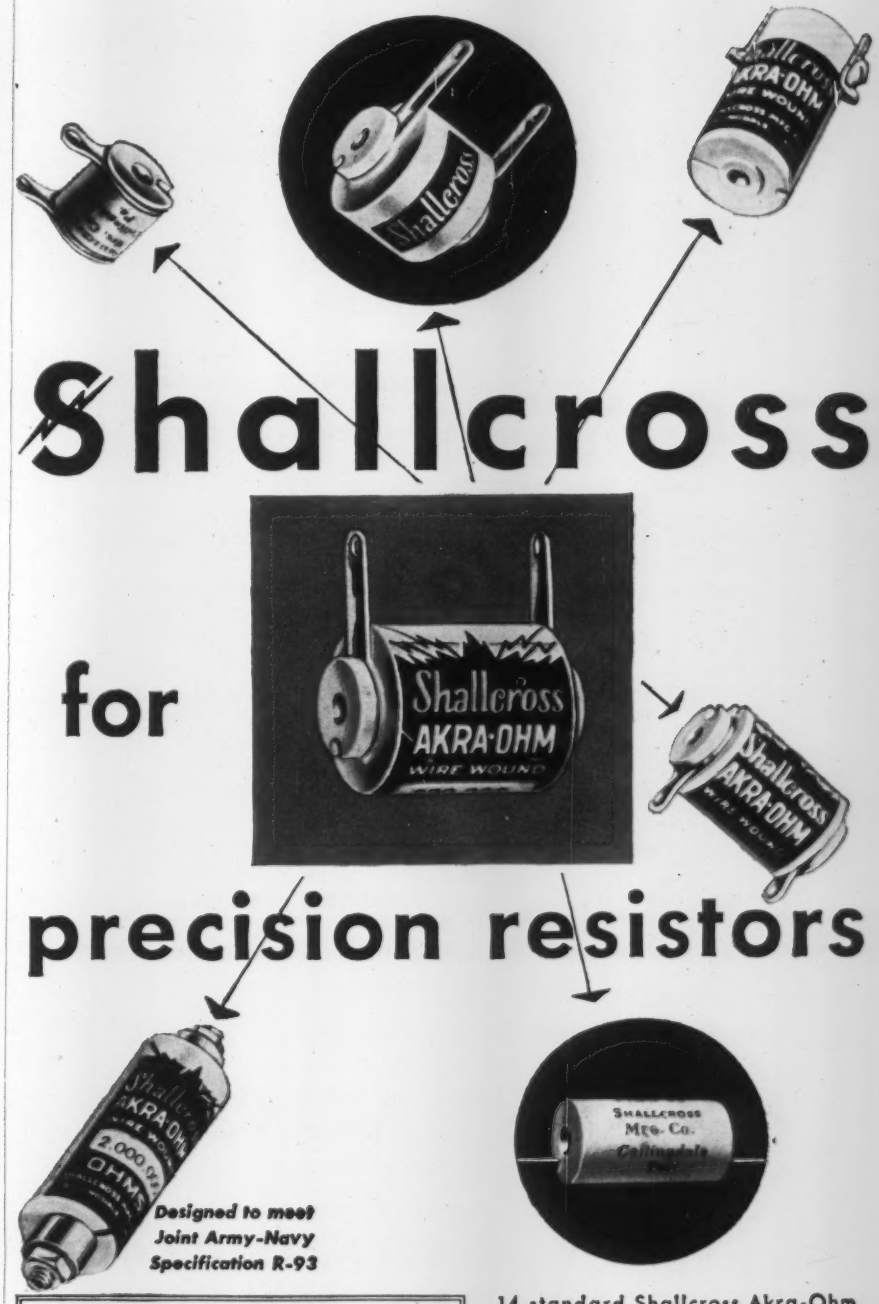


error method of finding correct center with a compass. It is made from transparent drafting-quality 0.030" plastic sheets; edges clean cut and smooth; 4½" diam.—*Ravidesian, Inc., P. O. Box 592, Glendale, Calif.*

Please mention number 1040 when filling out card

Surface Profile Recorder

New "Proficorder" provides a magnified chart record of shape, height and spacing of surface irregularities: true profile of practically any machined or finished surface. It is designed particularly to show waviness, bows, steps and other surface irregularities spaced approx. 1/32" apart or farther, rather than closely-spaced irregularities which make up surface roughness. Thus, in machining and grinding applications, its primary function is to show irregularities caused by machine or set-up used to produce surface, rather than showing roughness caused by cutting action of tool or wheel. However, fine roughness irregularities can also be recorded in full detail. Equipment is ruggedly built for shop use; includes (1) Tracer with diamond tracing point; (2) Piloting Fixture with motor-driven slide for moving Tracer; and (3) "Am-



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1.5 to 200 KV

BRIDGES
Wheatstone, Kelvin-Wheatstone, Percent Limit and Fault Location Types

DECADE BOXES
1 to 7 dial types, 0.1 to 11, 111, 110 ohms

VOLTAGE DIVIDERS (DECADE POTENTIOMETERS)
Voltage ratios 0.0001 to 1.0

LOW RESISTANCE TEST SETS
From 200 micro-ohms to 100 ohms

ATTENUATORS & CONTROLS FOR COMMUNICATION EQUIPMENT

14 standard Shallcross Akra-Ohm Precision Resistors and 50 available adaptations combining special terminals, mountings and power ratings match almost any specification.

Normal accuracy is ±1%. Tolerances as close as 0.05% where required. Temperature coefficient to meet any requirement. All types can be wound with either manganin, copper-nickel, or nickel-chrome or other wire alloys as desired. All designs are highly moisture repellent and unaffected by humidity. Normal resistance ranges from fraction of an ohm to 20 megohms.

Write for free copy of Shallcross Precision Resistor Guide

SHALLCROSS MANUFACTURING CO.
Dept. IS107, Collingdale, Pa.

Gaertner

NEW BULLETINS AVAILABLE

The following new or recently revised bulletins contain much useful information regarding Gaertner instruments. Copies will gladly be sent to those who request them.

OPTICAL BENCHES AND ACCESSORIES (156-74)

DIVIDED CIRCLE SPECTROMETERS (157-74)

PRECISION SPECTROMETER (L 123)

WAVELENGTH SPECTROMETERS and MONOCHROMATORS (158-74)

BUNSEN KIRCHHOFF SPECTROSCOPES (154-64)

RING SPHEROMETER (M 404)

INTERMEDIATE QUARTZ SPECTROGRAPH (L 251-64)

LARGE QUARTZ SPECTROGRAPH (151-74)

INFRA-RED SPECTROGRAPH (L 238)

DILATATION INTERFEROMETERS (140-74)

LARGE TOOLMAKER MICROSCOPE (154-64)

STANDARD TOOLMAKER MICROSCOPE WITH ROTARY STAGE (M 2001ARS)

AUTOMATIC LINEAR DIVIDING MACHINES (153-64)

Other Gaertner products are described in Catalog M 138, Instruments of Precision

THE GAERTNER SCIENTIFIC CORP.
1211 WRIGHTWOOD AVENUE, CHICAGO 14, U.S.A.

Reypo QUICK ACTION VISE

Quick action accomplished by pushing barrel and screw assembly (A) at point (B) until jaws contact work. A partial turn of screw (C) holds job. To release: Half turn of screw reduces pressure; flick of lock lever (D) permits withdrawing jaw

INDISPENSABLE WHERE PRECISION COUNTS

Accurately machined dove-tail slide with adjustable gibs prevents wobble. Both jaws fitted with hardened removable inserts. Finest materials. Highly finished.

Other Reypo units for use with Quick Action Vise: Swivel Base, Hand Vise and Handle. Reypo Quick Action Vise is also available in bench type, No. 107. Folder on request. At your dealer or write Dept. 87.

Reypo CORPORATION 1233 Lincoln Boulevard · Santa Monica, California

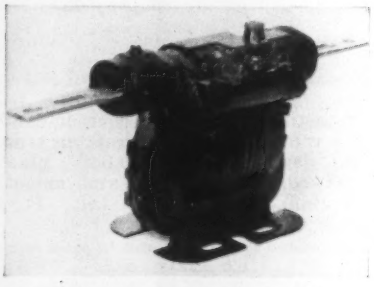
Makers of REYPO MODEL MASTER WOODWORKER . . . REYPO MODEL MASTER METALWORKER . . . Send for Folders

plicorder" unit consisting of amplifier, chart-recording mechanism and control panel, assembled in a cabinet mounted on casters. Various Tracers and Piloting Fixtures provide for profiling on flat or cylindrical surfaces, external or internal, and on remote portions of large surfaces such as machined base plates, rolls and cylinder bores. Maximum length of trace, approx. 2".—*Physicists Research Co., 321 S. Main St., Ann Arbor, Mich.*

Please mention number 1041 when filling out card

All-purpose Current Transformer

New "Type CT-2.5" current transformer is designed for instrument, relay and meter work, has class 0.3 accuracy with B-0.1, B-0.2, and B-0.5 bur-



dens—highest standard recognized by American Standards Association (C-57) at price levels no higher than older "Type KO" transformers suitable only for relaying. Impulse strength has been increased to 45 kv. as added protection against lightning and switching surges. Available for indoor use in the 2.5-kv. class of insulation for operation on circuits of 2890/5000 volts or less, new transformer is produced in ratings from 10 to 800 amperes with a full-load secondary current of 5 amperes in all sizes.—*Westinghouse Electric Corp., Box 1017, Pittsburgh 30, Penna.*

Please mention number 1042 when filling out card

Instrument-shop Center Punch

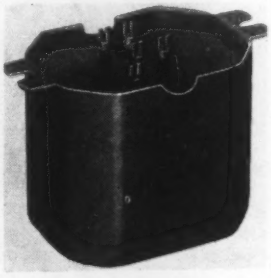
New "Impakt" self-acting center punch has a low-mass coil spring moving a short distance at high velocity to strike the point. Impact is controllable:

a light tap results when control knob is withdrawn about ⅛" and a heavy blow when full stroke of ⅝" is used. New punch is 5/16" in diameter, 5" long; weighs ½ oz.—*Satterlee Products, 755 Boylston Street, Boston, Mass.*

Please mention number 1043 when filling out card

Photo-flash Transformers

New series of transformers designed especially for photo-flash use includes: (1) "PF-1" transformer which has a 110-volt primary, a secondary which provides up to 2200 volts d.c. after rectification to capacitor, and a filament winding for required 2X2 rectifier tube. (2) "PF-2" transformer primary is tapped for 4 or 6-volt battery operation with full-wave vibrator; secondary has same 2200-volt rating for ca-



pacitors up to 60 mfd. Both transformers weigh 2 lbs. and are compound-sealed in steel cases 2⅛" × 2¾ × 2½" high. (3) "PF-3" trigger transformer delivers a 15-kv. peak and is used to control firing of flash tube; it derives its voltage as a pulse from d-c. network.—*United Transformer Corporation. 150 Varick Street, New York 13, N. Y.*

Please mention number 1044 when filling out card

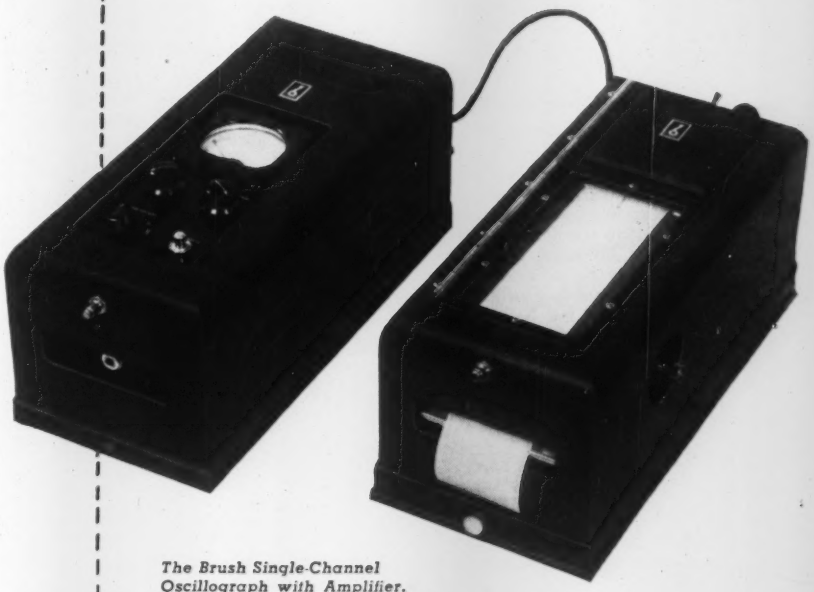
Hoist Load Weigher with Limit Signal or Cut-out

New "Dyna-Switch" weighs loads up to 10,000 lbs., flashes caution signal, rings bell, and cuts out hoist motor on chain or cable hoist and overhead cranes. It can be attached between overhead rail and hoist, or between hoist chain and hook. On cranes it is placed directly on hook. It withstands accidental overloads without affecting calibra-

Strain Recording is

INSTANTANEOUS

with Brush Oscillographs



The Brush Single-Channel Oscillograph with Amplifier. Oscillographs available in Double and Six-Channel units also.

Instantaneous, permanent, ink-on-paper recordings by Brush Oscillographs make their use almost unlimited. Accurate recordings of strains, pressures and countless electrical phenomena can be made over a frequency range of D.C. to 100 c.p.s. Either A.C. or D.C. signals can be measured. Whenever desired, recordings may be stopped for notations on chart-paper.

Investigate *Brush* measuring devices before you buy . . . they offer more for your money.

Write today for detailed information on this equipment.

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Canadian Representative: A. C. Wickman, (Canada) Ltd., P. O. Box 9, Station N, Toronto 14

New VACUUM-TUBE VOLTMETER

measures

both voltage and decibels

—with push-button selection

This new G-E instrument is a highly sensitive electronic voltmeter that can do a combination measuring job for you: Readings from 0.001 to 300 volts can be made in ten ranges at all frequencies from 10 cycles to one megacycle; the decibel range is from minus 65 to plus 45 from a reference level of 6 milliwatts in 500 ohms. A ten-position push-button switch allows any working range to be selected instantly without passing through intermediate ranges.

DIRECT READING—STABLE OPERATION—PORTABLE

Measured values are read directly from a G-E microammeter having a dual-voltage scale graduated zero to three and zero to ten, and a decibel scale graduated minus five to plus 15. The two-stage amplifier is stabilized by negative feedback, and the effect of normal-line-voltage variations is minimized by a voltage-regulator circuit that stabilizes the voltage output of the built-in power supply. Convenient portability of this 13-pound instrument is assured by the balanced location of the snap-up leather handle and the six-foot cord furnished for operation from a 110-volt supply circuit. Write for leaflet GEA-4574. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

PYRO THE SIMPLIFIED OPTICAL PYROMETER

SAVE TIME AND MONEY!

By using PYRO, a self-contained, DIRECT READING, sturdy unit made to stand rough use. It is absolutely accurate and dependable, and quickly pays for itself.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 5000° F.

Bulletins on PYRO Optical, Radiation, Surface and Immersion Pyrometers on request.

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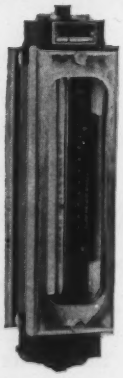
The Full-View ROTAMETER

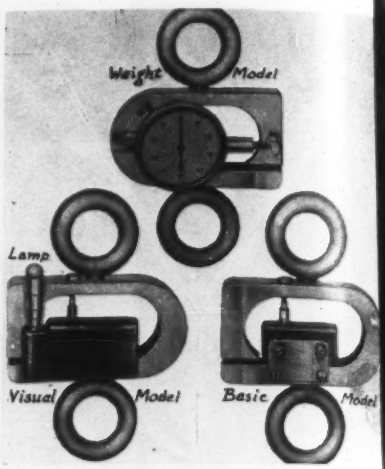


gives old-time accuracy

We have gone back to the "old days" when rotameters first became popular. Then every rotameter was actually calibrated. We no longer accept so-called standard calibrations from tapered tubes and floats made to tolerances. *Every direct-reading Full-View rotameter is individually calibrated for the conditions under which it will operate.* This method guarantees high accuracy. For full information, write for Folder No. 20, Brooks Rotameter Company, Box A-51047, Lansdale, Pa.

BROOKS ROTAMETER CO.

LANSDALE, PA.



tion. "Dyna-Switch" is made in "Basic" model with motor cut-off; "Visual" model with red caution lamp; an "Weight" model in seven types; fro 0-100 lbs., to 0-10,000 lbs., with indic tors showing 1- to 100-lb. division. Length 7⅞" from top to bottom of eye bolts, weight 3¼ lbs. Switch is Burge "Micro-Switch" type.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicag 44, Illinois.*

Please mention number **1045** when filling out card

Fuse Resistor

New "Type OWA" wire-wound re sistor performs functions of a resisto and of a fuse: at a relatively low level unit functions as an ordinary resistor;

at a higher power level it functions as a fuse and opens circuit when wire burns out. It is designed to individual circuit requirements, and is available in RMA values from 15 to 150 ohms. Power rating is one watt. — *International Resistance Co., 401 N. Broad St., Philadelphia 8, Penna.*

Please mention number **1046** when filling out card

Microammeter

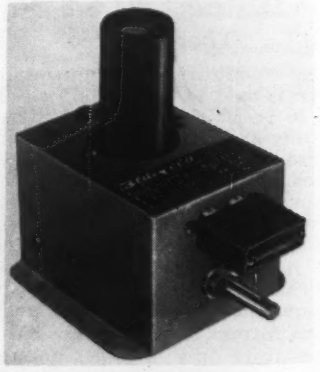
New "Model 301 Electronic Microammeter" is a high-sensitivity d-c. microammeter that cannot be damaged by any degree of overload. Five sensitivity ranges, from 0.01 microamperes full-scale to 100 microamperes full-scale, are provided, with 40-mv. full-scale input on all ranges. Instrument can also be used as a null-detecting galvanometer, with a sensitivity of approx. 10 mv. full-scale, or 0.0005 microamperes per division. D-c. amplifier is stabilized with negative feedback, so that zero drift after a short warm-up period is unnoticeable, and zero shift between ranges is negligible. Instrument operates satisfactorily over an input voltage range of 95-130 volts, 50/60 cycles. 3% full-scale accuracy is available. Sloping-panel steel cabinet is 8" × 8" × 8". Operation is said to be extremely simple. An internal calibrating circuit permits rapid check of accuracy at any

...e. Applications for new instrument ...n be found in photoelectricity, ioniz... ...ion-gage current measurements, high... ...sistivity measurements, biophysical ...search, etc., particularly in circuit ...here current may rise suddenly to a ...lue many times greater than fullscale ...ading with resultant injury to an ...dinary microammeter. — *Beta Elec... ...onics Co., 1762 Third Avenue, New ...ork 29, N. Y.*

Please mention number 1047 when filling out card

Crystal-controlled Oscillator

New "CCO-2A" crystal-controlled os...llator for 2-6-10-11 meters provides a ...mplete packaged nucleus for new ...nstruction or conversion of existing



...quipment. With this basic oscillator ...mploying a 6AG7 tube, advantages of ...HF crystal control are easily ...chieved. Unit uses maker's "AX2" 20-...eter crystals for output on 10 and 11 ...eters and new "AX3" crystals for 6 ...nd 2 meter operation; has direct out...ut on 6-10-11 meters and ample out...ut to drive tripler stage in 2 meters. ...Single tuning control, bandswitch and ...rystal socket are mounted on outside ...f painted metal subchassis with pow...r and output terminals at back.—*Bli...ey Electric Co., 200 Union Station Bldg., Erie, Penna.*

Please mention number 1048 when filling out card

Miniature Capacitors

New miniature capacitors are mold...ed in flat, mica-filled phenolic cases for ...se in electronic devices in which ...economy of space is a primary factor. ...Dimensions of available types: 0.001, ...0.005 mfd., $\frac{9}{16}$" × $\frac{5}{16}$" × $\frac{3}{32}$"; 0.05 ...mfd., $\frac{11}{16}$" × $\frac{29}{64}$" × $\frac{7}{32}$". Units are

You're FACE TO FACE WITH ALL THE FACTS

At a glance, the face of this CORBIN Tachometer will tell you the number of TONS PER HOUR, TONS IN BATCH and TOTAL TONS up to that time. Whether you're counting tons or cases, bottles, bales . . . or measuring in lengths, or counting revolutions . . . Corbin can engineer a Corbin Tachometer to meet your requirements.

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Corbin Screw Division
American Hardware Corp.
New Britain, Connecticut

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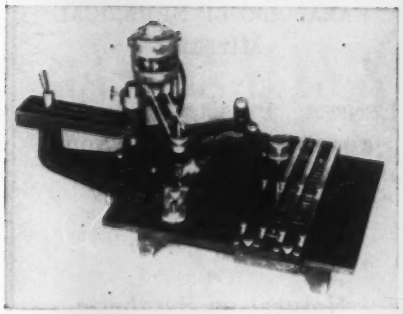
Accurate **CORBIN** *Tachometers*

—MICO— ENGRAVER



For lettering panels of steel, aluminum, brass, or bakelite, or for making finished apparatus.

Attachments adapt it to small or large work on flat or curved surfaces.

Excellent engraving can be produced by an inexperienced operator.

Widely used for production as well as occasional engraving.

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MICO INSTRUMENT CO.
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Automatic ELECTRIC PRODUCTS

TIME SWITCHES

Ruggedly constructed *Automatic* Switches have visible dial in tamper proof compact cabinet . . . pure silver contacts . . . 2 to 24 "on" and "off" operations. For any load . . . for every installation an *Automatic* time switch or Interval Timer will deliver superior performance.

Synchronous or Manually Wound

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Automatic heavy duty, motor driven Flashers available in circuit arrangements for every conceivable effect. Pure silver contacts. Models for any load or purpose.

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Automatic manufactures a complete line of dependable relays for industrial, business machines, radio, electronic and many other uses . . . open, or can type with tube-base, plug-in features.

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In Switches, Flashers and Relays where dependable performance is paramount, look for the "Diamond Seal for Diamond Quality".

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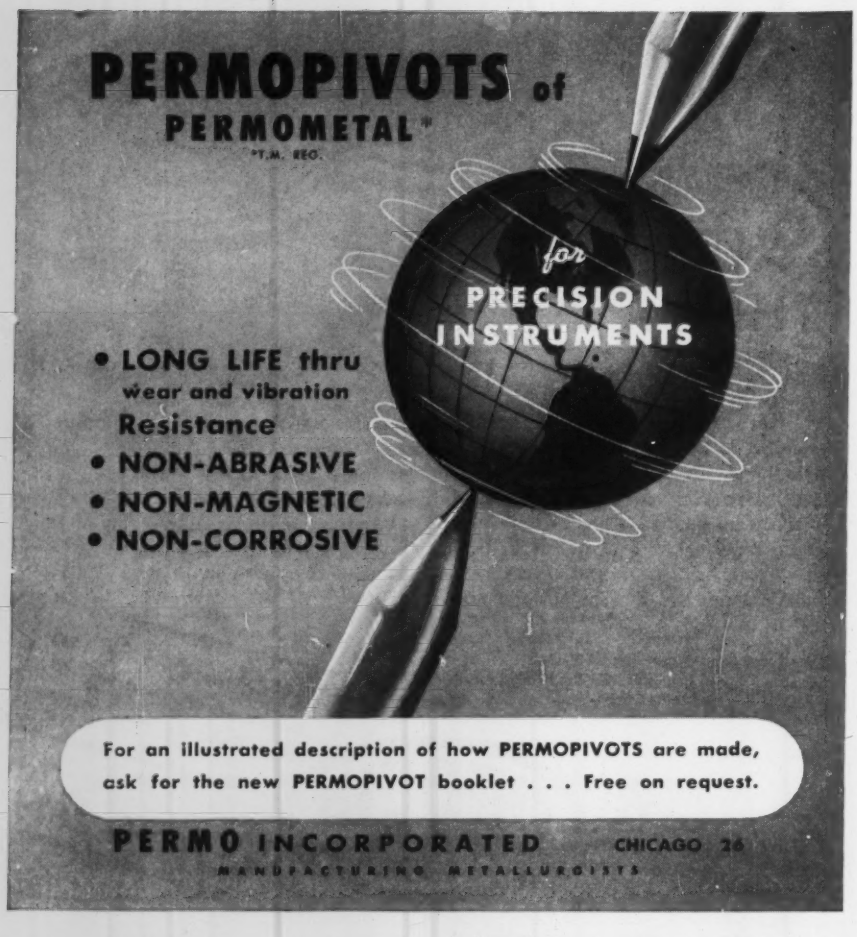

DIFFERENTIAL PRESSURE INDICATOR MODEL 181

- 6" HIGH VISIBILITY DIAL
- 0-50 INCHES OF WATER UP TO 0-200 P.S.I.
- UNIVERSAL MOUNTING
- RUPTURE-PROOF BELLOWS UNIT

Write for Bulletin 181-1

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3500 UNION PACIFIC AVE.
LOS ANGELES 23, CALIF.

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PARABOLIC or SPHERICAL Mirrors.

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LENSES, PRISMS or related components for your visual, photographic or electronic requirements.

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Natural or Synthetic CRYSTAL OPTICS.

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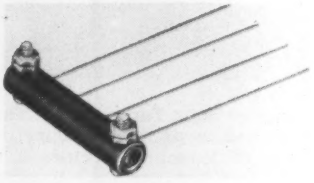
case-sealed against 80% relative h midity. Operating temperatures a −55°C. to + 65°C; the 0.001 and 0.0 mfd. ratings can also be furnished f service up to 85°C. Capacitance tole ance for 0.05 mfd. units, ±30%; for other units, +60% −20%. — *Deutschmann Corp., Canton, Mass.*

Please mention number 1049 when filling out card.

Selenium Rectifier

New "Model SE-8M20F" seleni rectifier is especially designed for lays and low-current control appli

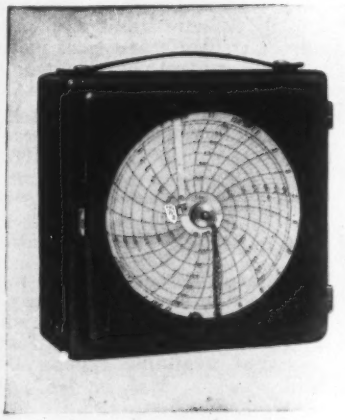


tions where space is limited. Rated 110 volts a.c., 80 volts d.c., 10 mil amperes d.c., new unit can be modifi to meet different electrical specifica tions. It has a tubular Bakelite ca ⅜" in diameter by 1½" long, with fo 2" tinned leads. It mounts on tw standard screws and is complete sealed against moisture and corrosi atmosphere. — *Bradley Laboratori Inc., 28 Meadow St., New Haven Conn.*

Please mention number 1050 when filling out card.

Miniature Recording Thermometer

New miniature-size temperature re corder is said to be the only one of it type to resist shock and vibration su cessfully and to be particularly suitab for use in trucks, railroad cars and ai planes in transit as well as in other op erations where vibration is encountere Because of its small size (5¾ squar by 4¼" deep) and portability (<3½ lbs.) it is also useful for checking re frigerating, heating and air-conditio ing equipment. Instrument is availabl in two forms: single-pen for recordin temperature only; two-pen for record ing time of refrigeration motors in ad dition to temperature. Transparent un breakable plastic front permits ful view of entire chart and pen-arm. Pen arm being "jiggle-proof," temperatur record is unaffected by vibration. In

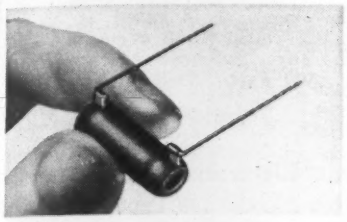


...rument is available in a wide variety of ranges, choice of 24- or 72-hour charts (7-day-spring chart drive). Case is aluminum, with smooth, black enamel finish.—*C. J. Tagliabue Mfg. Co., Park and Nostrand Avenues, Brooklyn 5, N. Y.*

Please mention number 1051 when filling out card

5-watt Resistors

New 5-watt "Brown Devil" vitreous enameled wire-wound resistor ($\frac{5}{16}$" × 1") may be obtained in resistance val-



...ues from 1 to 10,000 ohms. Standard tolerance is ±10%.—*Ohmite Mfg. Co., 4952 Flournoy St., Chicago 44, Ill.*

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Coated High-index M-p. Lenses

New coated Baltar lenses for professional 16-mm. motion picture photography are made in 15, 17.5, 20 and 25mm focal lengths; are comparable in every way to longer-focus Baltars used by Hollywood cameramen. Utilizing new high-index glasses, each lens was independently designed for its individual field of view, and required two years to develop. Basic optical design consists of four meniscus-shaped elements, each of two inner components made up of two elements cemented together. To achieve exact alignment, each lens section is mounted in an individual cell; whole assembly is held in place with a single retaining ring, in the same manner that B&L microscope objectives are mounted.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.*

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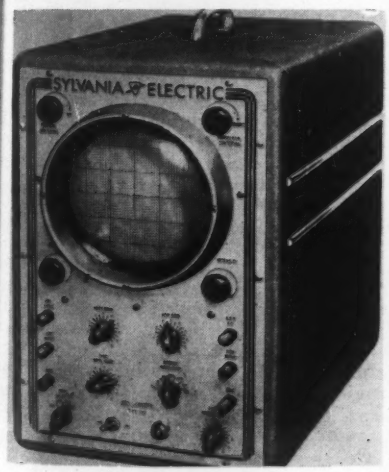
Cathode-ray Oscilloscope

New "Type 132" seven-inch cathode ray oscilloscope suitable for a wide range of applications in radio and electronic circuit alignment, industrial pro-



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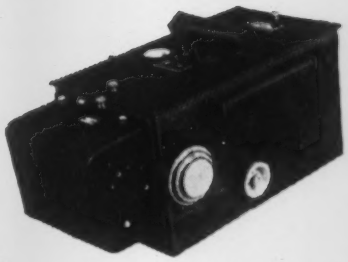

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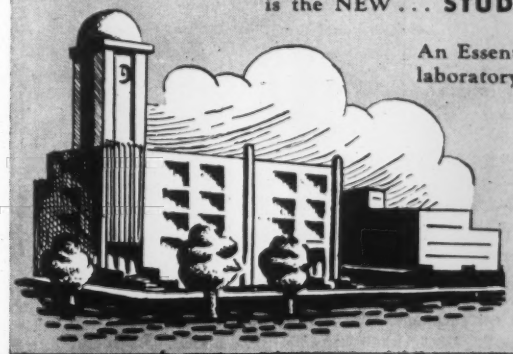

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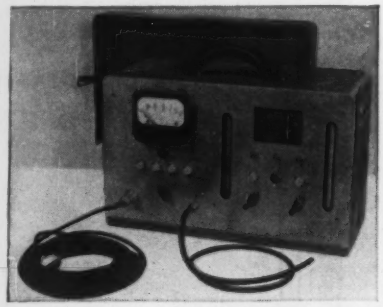

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duction and instruction in schools and colleges, features an improved type push-pull amplifier using four 7[illegible] tubes, providing clearer patterns, less distortion and considerably more gain than conventional single-stage amplifiers used in general-purpose instruments. Provision is made for Z axis input with impedance to ground approximating ½ megohm with 30-μμf. shunt capacitance. This feature permits a wide variety of study in industrial applications where desirable to study portions of wave-forms by means of intensity modulation. New oscilloscope weighs 37 lbs. and is 17" high, 11⅜" long and 17¾" deep. It is rated at 35 watts, 105-125 volts, 50-60 cycles a.c.—*Radio Tube Div., Sylvania Electric Products Inc., 500 Fifth Avenue, New York 18, N. Y.*

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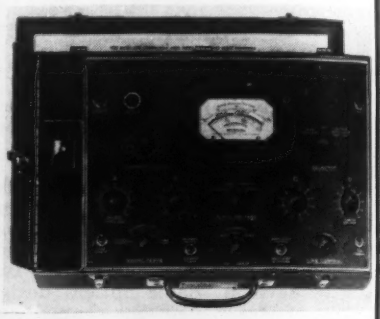
Electron Tube Tester

New "Model 798 Type 5" proportional mutual conductance tubechecker not only tests all receiving tubes but also handles voltage-regulator tubes and



low-power thyratrons as well. Using a radically new differential-frequency method of tube testing, it provides proportional mutual conductance readings under conditions which closely resemble actual operation. "Good-Bad" readings also, are provided. Sixty-cycle a-c. potentials are used on tube elements thereby approaching zero plate load conditions most desired for mutual conductance tests. A separate internal 5-kc. signal is applied to control grid and resulting plate component of the high-frequency signal is measured on a rectifier instrument. All types of tubes can be properly tested without overloading. Three signal voltages 0.75/1.5/3 volts, provide mutual conductance ranges of 12,000, 6,000 and 3,000 micro-ohms, without overdriving or tube damage. In addition to tests of receiving-type tubes it provides ("for the first time in any tubechecker") adequate tests on certain special classes of industrial and control tubes. It will indicate static and regulating characteristics of voltage regulator tubes such as VR105 and VR150, and will test thyratrons 884,885,2A4, 6D4, 2050, 2051 and similar low-power tubes. Grid bias, plate voltage and instrument sensitivity are independently adjustable from separate controls. In addition, an extremely flexible switching circuit provides for testing of new tubes as they are brought out, with one spare octal and one spare miniature socket provided. — *Weston Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, N. J.*

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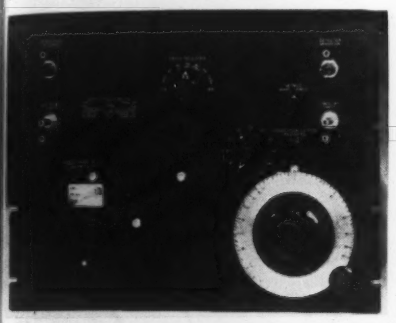
Capacitance Bridge

New "Type 716-C Capacitance Bridge" is designed to fill gap between a-f. bridges and r-f. types; measures capacitance and dissipation at all frequencies between 30 cycles and 300 kc. Uses for which it is particularly suited include measurement of dielectric constant and dissipation factor of dielectric materials as a function of frequency. Frequency range covered is sufficient to show effects of interfacial polarization at low audio frequencies and of dipole dipolarization in polymers. Effect of surface water films on insulators can be measured, as can Boella effect in resistors. Its accuracy (±0.2% for capacitance; ±2% for dissipation factor) and wide range make it particularly suitable for intercomparing capacitors in standardization measurements. Circuit is that of conventional Schering bridge, using a General Radio precision capacitor as the standard capacitance. A newly-designed shielded input transformer with polystyrene tape insulation makes possible the extended upper frequency limit of operation. Direct-reading capacitance range



is 100 μμf to 1 μf at 1,000 cycles and 100 μμf to 1100 μμf at other frequencies. Using substitution method of measurement, range is from 0.1 μμf to 1,000 μμf. Dissipation factor range is from 0.00002 to 0.56. Bridge is supplied either in a walnut cabinet or for rack mounting; net weights 53¾ lbs. and 41½ lbs. respectively.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

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Test Oscillator

New "Type WR-67A" test oscillator provides three fixed frequencies for high-speed servicing of radio receivers, simplifies alignment of superhet and tuned-r-f. receivers. A 455-kc. position is provided for aligning i-f. channels, while 600-kc. and 1500-kc. signals are used for alignment of r-f. and local oscillator circuits. New instrument can also be used for general trouble shooting, measuring of response characteristics, analyzing circuit performance, and determining stage-by-stage gain. Signal injection probe supplied with instrument simplifies application of i-f., r-f., or audio test signals to any part of a radio receiver without use of clip connections. "WR-67A" contains a compensated Hartley-type oscillator which maintains stable operation over entire frequency range of 100 kc. to 30 Mc. and has an internal source of modulation of 400 cps. Degree of modulation is adjustable up to 50% and a jack is provided for external ampli-

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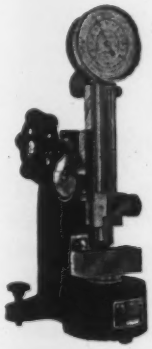

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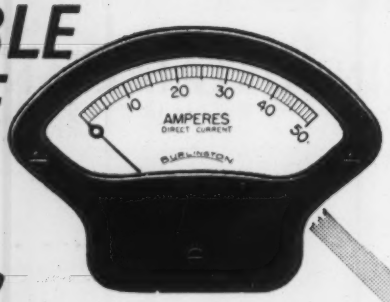

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tude modulation. (When it is used as audio oscillator serves as an amplifier.) Dimensions 13½" × 9¾" × 7½"; weight 15 lbs.—*Test and Measuring Equipment Dep't, RCA Victor Div., Radio Corporation of America, Camden, N. J.*

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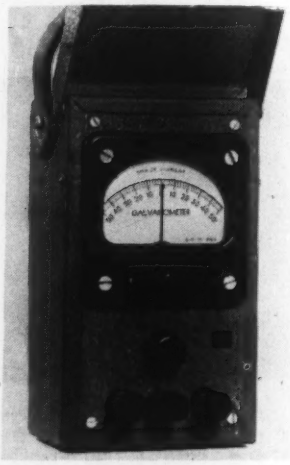
Impedance-matching Bridge

New simplified bridge instrument for checking quantities of identical components against standards, is available in three models to suit any requirement: "Model 70," low sensitivity; "Model 71," medium sensitivity; "Model 72" for use with high-sensitivity laboratory galvanometers. It is completely adaptable to any test set-up where a-c. impedance can be used as the indication; is easily operated by unskilled workers: instantly indicates whether impedance matches standard or is over or under; permits rapid grading of capacitors, resistors or re-



actors; detects shorted turns in coils or insulation, leakage in transformers, chokes, motors, appliances, etc. Sixty-cycle current serves for most tests, but unit is designed to permit use of frequencies as high as 75 Mc. It contains no tubes. "Balac" rectifier unit is a plug-in assembly for easy replacement.—*Conant Electrical Laboratories, 6500 "O" St., Lincoln 5, Neb.*

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Instrument Lubricants

New "DC 710 Type" silicone oils for high-temperature lubrication, especially in timing mechanisms, precision instruments, etc., are said to have exceptional heat stability combined with high resistance to oxidation, freedom from gumming, water repellency, low volatility and high flash points. These properties make them suitable for use at temperatures ranging from 10°F. to 500°F. (−12°C. to 260°C.) "DC 710R" contains a corrosion inhibitor and provides permanent lubrication for such sealed-in precision devices as clocks and instruments exposed to high or normal temperatures. "DC 710G" containing colloidal graphite in suspension, lubricates mechanisms continually exposed to extreme heat, weather, or high humidity.—*Dow Corning Corp., Midland, Mich.*

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JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
I.S.A. National Office, 1117 Wolfendale St., Pittsburgh 12, Penna.

Vol. 2 OCTOBER 1947 No. 10

Outgoing President's Annual Report

TO THE MEMBERS OF THE INSTRUMENT SOCIETY OF AMERICA:

My first pleasant duty is to assure the Board of Directors that their officers, and almost all of their committees, have worked hard and successfully throughout the year in a fine atmosphere of sincerity and cooperation. It is especially gratifying to one who has so much confidence in the future success of our Society to contemplate the able administration of our National Office by Dick Rimbach in his evident love for the Society's well-being.

It is only proper that I thank the members of our Executive Committee in the name of the Society for their cooperation and advice, and also the chairmen of the committees and their members for their labors of the year. Appreciation of work well done is difficult by those who are not fully in touch with the details, and the members of our Board might try to realize this while they view the success of our Annual Conference and Exhibit, for which not only our Executive Secretary, but many other able fellows, especially of the Chicago Section, have labored so prodigiously. Congratulations to the Chicago Section cannot be too strongly expressed. In speaking of the Chicago Section, I do not mean to exclude our Meetings Committee, a standing committee of the National Society, under the able chairmanship of Al Sperry, whose interest in the welfare of the Society did not falter at the end of his term as first President.

Our prestige as a National Society has progressed favorably, not only because of the success of the first Annual Conference in Pittsburgh last year and the immediate success of our Second Annual Conference, but also because of the care with which our officers have pursued proper policies. We again enjoy this year the cooperation of the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers, of which the chairman, J. C. Peters, and the secretary, Paul Exline, our new President, are at the same time very active members of our Society. It is also a pleasure to report at this time that the initial doubts of the *Scientific Apparatus Makers of America* have changed to hearty cooperation during the year, and also, due to the wisdom of our Executive Secretary, that the Exhibitors' Advisory Committee has functioned smoothly and successfully.

Just a few words about the 1948 Conference to be held in Philadelphia. Here again our sound growth is indicated by the interest of the American Institute of Physics, which, at our suggestion, will probably hold a symposium on scientific instruments during our Conference. Our Secretary has already reported many other arrangements already completed for next year's Conference, and we can be confident that our strong Philadelphia Section will enthusiastically compete with the records of the Chicago and Pittsburgh Sections.

You have all known of our difficulties in the preparation of material for publication and the problems involved, and you are learning at these meetings that our publications will from here on grow and be more directly evident to an impatient membership. Our important activities in the fields of education will grow at a pace which I am confident will soon amaze you—activities both at the level of vocational training and at so-called higher levels of scientific and engineering knowledge. We must endeavor to place our Society in a position to afford experienced and expert advice to the teaching staffs of universities and technical schools, and I firmly believe that this will come to pass in the near future, especially if we can retain the fine services of Dick Teare as chairman of the Education Committee. We must also improve our prestige to the point where our recommended practices will be accepted and respected by other institutions. These *will* be accepted if they continue to be developed as well in the future as they are now under the able chairmanship of Fred Trapnell.

Speaking of committee chairmen, this is a good time to refer especially to the thorough job completed by Bill Wildhack, who formulated the duties and responsibilities of all of our committees and did much to clarify the working structure of the Society.

It is probably not one of my duties to report in detail on the finances of the Society, but at least I can enjoy the pleasure of commenting on our good fortune in having such men as our Treasurer Hugh Ferguson and Finance Chairman Al Shafer. The strenuous endeavors of these two men have worked to the great advantage of our Society, and their abilities have been clearly evident to you.

Our prestige as a National Society will, I am confident, grow at an astonishingly rapid rate. Faculty members are coming to us for advice in increasing numbers, and we will soon be able to help hundreds of instrument men in their endeavors to obtain an education. We may not soon be on an even footing with professional societies, but nevertheless, we will become widely known both in this country and abroad. My own confidence in the future of our Society is deeply rooted because I am especially conscious of the absence of

(Continued on page 969)

(Editor's Note: In lieu of a leading editorial this month, which would have been directed toward some of the highlights in the following report, we herewith present in full the annual report of our retiring President, C. Owen Fairchild. This report was read by Mr. Fairchild at the annual meeting of the Society on Monday, September 8, 1947, during the Second Annual Instrument Conference and Exhibit at the Stevens Hotel in Chicago.—RRP)

New Officers for 1947-48

At the Board of Directors meeting on Saturday, Sept. 6, 1947, the following officers were elected to replace the retiring President and two Vice-Presidents.

President: Paul G. Exline, Section Engineer, Gulf Research and Development Company, Pittsburgh, Penna. (Term of office, 1 year) A "Who's Who" article on Paul appears elsewhere in this issue.

Vice-President: H. C. (Jack) Frost, Assistant Director of Engineering, Chemical Division, Corn Products Refining Company, Argo, Ill. (Term of office, 2 years). Jack, as Chairman of the Papers Committee for the 1947 Conference, was written up in our "Who's Who" department in the February, 1947, issue of the JOURNAL.

Vice President: Fred H. Trappnell, Instruments Engineer, Design Division, Engineering Department, E. I. du Pont de Nemours & Co., Wilmington, Del. (Term of office, 2 years). "Trap" is Chairman of the Recommended Practices Committee, and was the subject of one of our "Who's Who" articles in the June, 1947, issue of the JOURNAL.

These men were elected to fill the vacancies created by the expiration of the terms of office of (respectively) C. O. Fairchild, J. B. McMahon and Ralph H. Munch. These three retiring officers will continue to serve on the National Executive Committee, however—Ex-President Fairchild by Constitutional authority (Article VII) and Messrs. McMahon and Munch by action of the Board of Directors, also covered in Article VII of the Constitution.

The remaining officers of the Society, each starting the second year of his original two-year term of office, are: First Vice-President Carl F. Kayan, Vice-President Herbert H. Barnum, Treasurer Hugh E. Ferguson, and Executive Secretary Richard Rimbach.

Sea Water Bromine Process Chemical Control Systems*

By PORTER HART (Superintendent of Instrumentation, Texas Division, Dow Chemical Company)

EARLY in the 1930's the first chemical plant for the commercial extraction of bromine from sea water was built at Wilmington, North Carolina. Since that time several expansions have been made there and also a new plant with expansions has been built at Freeport, Texas. The bromine taken from sea water is manufactured into ethylene dibromide which is used largely in conjunction with tetraethyl lead in the treatment of gasoline motor fuel.

This process consists essentially of (a) acidifying sea water and oxidizing it with chlorine to liberate free bromine, (b) blowing the free bromine out of solution with air, (c) mixing the bromine-laden air with SO_2, and (d) passing it through absorbing towers with water forming hydrobromic acid and sulphuric acid solution. This hydrobromic acid solution is again chlorrinated to free the bromine which is driven off with steam and collected in the liquid form.

Sea water contains about 3½ per cent total solids but only 60 to 70 parts per million of bromine. This is approximately the same bromine content as that of the waste effluent from the commercial bromine process using Midland brine from wells. Consequently, extensive laboratory work was required to solve the control problems for the efficient removal of bromine from sea water. It was realized that the addition of acid, chlorine, and SO_2 to the process must be very closely controlled to obtain a satisfactory yield of bromine from sea water, and control schemes for pH, oxidation potentials, solution conductivity, gas analyses, etc. were devised to make a satisfactory recovery of the bromine.

Chemical Reactions:

(1) $2NaBr + Cl_2 = 2NaCl + Br_2$

(2) $Br_2 + SO_2 + 2H_2O = 2HBr + H_2SO_4$

(3) $2HBr + Cl_2 = 2HCl + Br_2$

With the use of the ocean as a source of bromine, such enormous quantities of water are involved that continuous methods for recording and controlling the acidity and chlorination of sea water were necessary to reduce the possibility of large losses in acid and chlorine, and methods were finally developed to answer all the control requirements in the process.

The extraction of bromine from sea water takes place in a blowing out tower in which a current of air removes the bromine from acidified and oxidized sea water. The bromine-laden air from the tower is mixed with SO_2 in a duct system connected with a water absorption system collecting the hydrobromic and sulphuric acids. In order to obtain satisfactory controls on this system it was necessary to devise methods for holding constant the strength of the acid and SO_2 and also control chlorine pressure so that in reality the only things that would affect control changes would be the sea water salinity, the rate of pumping, and atmospheric conditions.

The Author

Porter Hart, Dow Chemical Company, has been Superintendent of Instrumentation of the Texas Division, Texas City, Tex., since 1930. While working in the Physical Research Laboratory in Midland, he spent most of his time on the development of chemical control systems and potentiometric measurements. During this period the Physical Research Laboratory developed the glass electrode for industrial pH control. This, along with the development of other electrochemical measuring systems, led to the application of chemical process controls to the sea water bromine process. Hart was active in the engineering and application of these controls both in the Wilmington, N. C. and Freeport, Texas bromine plants.

Treatment of Sea Water for Bromine Extraction

During normal operations over 150,000 gallons per minute of sea water are pumped into a seven foot diameter riser pipe to the distribution system on top of the blowing out tower. In this seven foot diameter riser pipe the acid and chlorine are added through multiport jets for mixing. The sample for control is taken off just before the treated sea water enters the distribution system over the blowing out tower. The velocity-distance lag is normally approximately 15 to 25 seconds and because the pH and especially the oxidation potential are operating on relatively steep slopes of their titration curves and in view of the fact that they effect each other, it is very important that everything possible be done to help stabilize this system.

The pH for controlling the acidity of oxidized sea water must be measured with a glass electrode because of the presence of free halogen. In the sea water bromine plants the glass electrode pH for industrial use was pioneered. The Physical Research Laboratory developed special glass electrodes, vacuum tube balance systems, and control units to be used with industrial recorders having special potentiometric circuits. In the first installation, the cells were in a sampling location 1000 feet from the recorder and it required some time to eliminate electrical interference before automatic control could be used. The sensitivity of this first control system was 0.02 pH and its operation was very successful. However, in more recent sea water bromine plants, standard industrial glass electrode pH recorders and controllers are used, calibration range 2-7 pH. These controllers operate rubber-lined butterfly valves placed in a return line on the acid pumps from the acid mixing system which furnishes a constant concentration of acid for acidifying sea water.

The method of oxidation control depends upon the fact that for every bromide contained in solution there is a characteristic range of oxidation potential values. This range depends upon the initial concentration of bromide ions and also upon the collective effect of other ions present. It was found that in acidified sea water the first trace of free bromine in a solution that was being tested caused an immediate increase in oxidation potential. This rise was measured by the difference in voltage between a saturated calomel reference electrode (half-cell) and a platinum electrode. The relationship between the oxidation potential expressed in volts and the percentage of bromine liberated in acidified sea water is approximately 880 millivolts for 10% bromine liberated to 970 millivolts for 100% liberation.

After obtaining a clear understanding of these factors which made the most effective liberation of bromine from sea water and the development of satisfactory control methods, it was not difficult to hold the oxidation potential control within one-half millivolt during normal operations. (Fig. 1.)

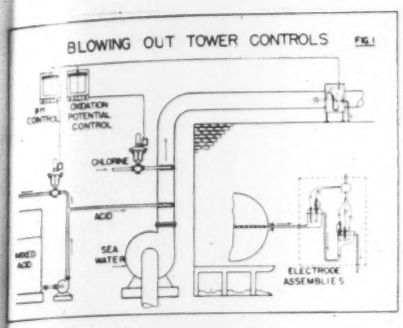
Acid Mixing System

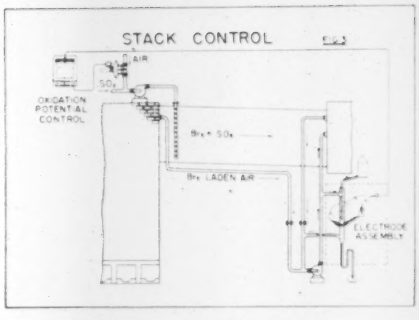
This system consists of an acid mixing plant which produces continuously a definite strength acid for acidifying sea water. It consists of an acid mixing tank built on top of the acid supply tank. Through the acid mixing tank passes an effluent acid which is about 60% of the acid requirement, returned from a reaction at the end of the process. Also, water is added from a level control on the supply tank and strong sulphuric acid is added to bring the acid up to its constant controlled strength. The acid which is by-passed by the control valve that acidifies sea water is also returned to the acid mixing tank so as to constantly readjust any variations in concentration in the supply tank.

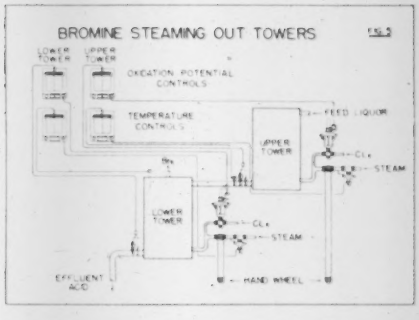
It was necessary to dilute a sample of the mixed acid in order to raise the pH to a range suitable for control. This was accomplished in a diluting system by mixing one part of mixed acid to 200 parts of sea water, bringing the pH of the sample to the electrode chamber up to a normal operating range between 2½ and 3 pH. (Fig. 2.)

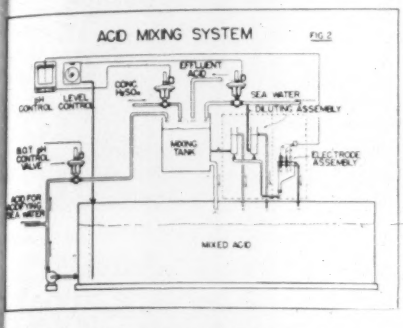
*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

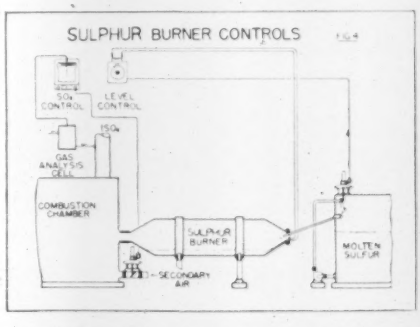
NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.











Sea Water Salinity Recorder

As an aid to operation, a sea water salinity recorder was designed using electrical conductivity cells in an AC Wheatstone bridge circuit. A standard reference sample was used for the cell in one arm of the bridge for temperature compensation, and in the other arm of the bridge circuit the salinity measuring cell was used. This instrument indicates and records in parts per million bromine, range 35-70 parts per million. It was necessary to shield this cell system from light to reduce marine growth on the electrodes.

So_2 Control

Controlling the SO_2 mixed with the bromine-laden air was one of the most difficult problems, due to the fact that this mixture properly controlled would contain a very slight excess of SO_2 so that after passing through the absorber there would be no bromine and a very minimum amount of SO_2 exhausted to atmosphere. At times this control was operated with such precision that the exhaust stacks were completely neutral.

A sample of the mixed gases passing into the absorption tower was drawn through a blower to the electrode sampling system and returned to the tower. Also, a controlled amount of bromine-laden air was drawn directly from the blowing out tower and mixed by the sampling blower to continuously titrate the excess SO_2 in the mixed gases. This was one to raise the oxidation potential for maximum sensitivity of the electrode assembly.

The final design of the electrode system was quite simple. The titrated gases were blown down through a small glass column and returned to the absorber. In the glass column hung a solid center rod pointed on the bottom end. A slightly acid solution passed down over about 10 inches of the glass rod dropping off the pointed end at a rate of approximately one to two drops per second on to the measuring system consisting of a platinum electrode and saturated calomel half cell reference electrode. This proved very successful because it had very little inventory effect. The platinum electrode and reference cell hold only the drop which is between them which is pushed off by the next drop. The film on the rod comes to a saturated equilibrium with the mixed gas very rapidly. Here again is another example of why it is necessary to hold all conditions possible very stable because this complete control system had a 20 second velocity-distance lag. The range of the recording potentiometer controller is 0-1000 millivolts. This controller operates a 16-inch air damper on the suction side of the sulphur dioxide blower which draws SO_2 from a sulphur burner. The titration of the mixed gasses with the bromine-laden air is regulated so that normally the electrode system is on the halogen side between 600 and 700 millivolts. (Fig. 3.) For promptly adjusting the system a gas sample is drawn from the stack to the control lab and titrated periodically with a photoelectric titrating device using iodine-starch solution.

Sulphur Burner Controls

Sulphur burners, until recently, had always been manually operated except for alarm systems used in flooding the cooling tower. A thermal conductivity type SO_2 gas analyzer was used to continuously record the per cent SO_2 from the sulphur burner. This instrument was connected up for controlling the secondary air betwen the sulphur burner and combustion chamber. The most valuable control that was put on the sulphur burner controlled the level of molten sulphur in the burner. This level system operated from a stainless steel dip pipe going in from the front end of the burner to beneath the liquid molten sulphur level and a second pipe just entering the sulphur burner chamber to compensate for burner pressure variations. Air purge systems were used on these pipes connected to a 20 inch water differential recorder controller. This controller operates the air motor connected to a swing pipe mounted in an enclosure on top of the molten sulphur supply tank. Molten sulphur is continuously pumped into the swing pipe having a fan-spray nozzle and is swung over a V-shaped trough carrying a controlled amount of sulphur to the burner. This control stabilized the operation of the sulphur burner so well that the secondary air control to the burner proved of little use. (Fig. 4.)

Bromine Steaming Out Towers

The steaming out towers for removing bromine from the hydrobromic acid formed in the absorbers are split into two units, an upper and lower tower. To the upper tower a part of the chlorine requirement is added and enough steam to raise the temperature to approximately 50°C. In the lower tower the remaining chlorine requirement is added to completely free the bromine and enough steam to completely vaporize the bromine which is driven off into condensers. These operations are set up for automatic control.

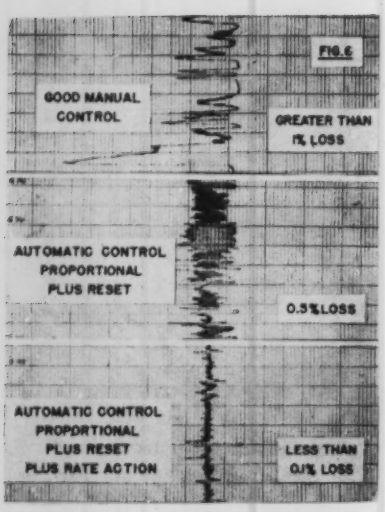
Steam to the upper tower is controlled from the temperature of the liquor (red water) leaving the upper tower flowing by gravity into the lower tower. The pneumatic temperature controller operates a steam regulator of the pressure balance type with a three to one ratio in diaphragm area to prevent the possibility of ever getting more than a few pounds steam pressure back of a manually operated throttling valve.

Steam to the lower tower is controlled in a manner similar to that of the upper tower except that the controls are operated from the vapor temperature in the tower.

To the upper tower is added approximately two-thirds of the chlorine requirement. The chlorine is controlled automatically from the oxidation potential. The measuring system is a platinum electrode and a saturated calomel reference electrode (half-cell). The potential is measured by a potentiometer recording controller, range 500 to 1000 millivolts.

The chlorine is controlled to the lower steaming out tower automatically from the oxidation potential of the effluent. The measuring system is a platinum electrode and a saturated calomel reference electrode (half-cell) and the potential is measured by an automatic recording controller (range 700-1200 millivolts) similar to that of the upper tower. (Fig. 5.)

The chlorine control to the lower steaming out tower is perhaps one of the most difficult problems encountered. Even the best trained operators standing at the control valve continuously could not satisfactorily regulate the chlorine. Halogen losses in the effluent would invariably be greater than one per cent under the best conditions. In fact, there was always considerable discussion that if the chlorine could not be satisfactorily regulated manually, how could it possibly be handled by automatic control.



In the first attempt at control, the potentiometer controller operated a pneumatically set flow controller to regulate the chlorine, and because the flow controller had square root characteristics, the system did not work satisfactorily. In by-passing this flow control and connecting the potentiometer controller directly to a percentage flow type control valve, good results were immediately obtained but effluent losses were still at the best operation one-half of one per cent, which was considered very good. Later, second derivative control was incorporated in the pneumatic system with the most satisfactory results, and now halogen losses in the effluent are normally less than one-tenth of one per cent. This control problem is complicated by the very nature of the oxidation potential titration curve of bromide with chlorine. (Fig. 6.)

When there is excess bromine or chlorine in the effluent, the recorder operates on very flat parts of the curve and changing from one condition to the other is the very sharp break that occurs between 850 and 1025 millivolts and on this break is the halogen free effluent. To further complicate the control problems, the towers are periodically upset because the ethylene-dibromide reactor vents and wash waters are discharged into them.

The control room for this operation is adjacent to the building with sealed windows and valve handles coming through the wall from the operating area. This is necessary so that the operator could safely shut down the steaming out towers if equipment should fail causing a bromide vapor atmosphere. (Fig. 7.)

Chlorine Control Piping

All chlorine control piping, consisting of orifice meter runs, flow and pressure transmitters, control valves, and chlorine gas analyzers, is mounted on the roof of the control rooms. The reason for this is that regardless of what direction the wind may be blowing any chlorine leaks that may occur will be blown away from the control room area. (Fig. 8.)

The pressure and flow transmitters are purged with air to protect them from the chlorine. Where the purge lines connect onto the chlorine system the pipe is brought straight up approximately 6 feet before continuing to the instrument connections. This is to prevent the heavier chlorine gas from flowing counter-current to the air purge.

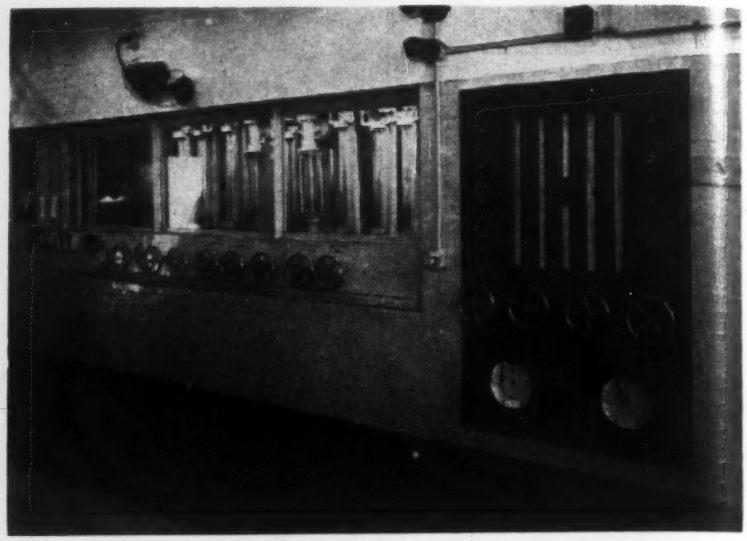


Fig. 7

Because of two sources of chlorine which are used together in the end result, it is necessary to flow control one source while the other supply is used for pressure regulation. In this system both supplies have flow and pressure transmitters connecting through a transmitter line air switch which permitted either flow or pressure regulation on either source at any time.

The by-passes around control valves were practically eliminated. There were only two installed. These were around the two control valves going directly to the blowing out towers and are used less than once a year. Eliminating by-passes was done for two reasons: because they were so seldom used that when required by-pass valves were generally stuck so badly they would not open, and because it is difficult to operate without automatic control.

The Control Instruments

All recording instruments used in the measurement of pH, oxidation potential, gas analysis, sea water salinity, and temperature are self-balancing potentiometers of the galvanometer type. The controllers are recording with pneumatic control systems, operating control valves equipped with positioners. With this equipment the production of liquid bromine from raw sea water is completely automatically controlled except for manual operations consisting of adjusting pumping rates, forwarding liquors, unloading raw materials, and similar operations.

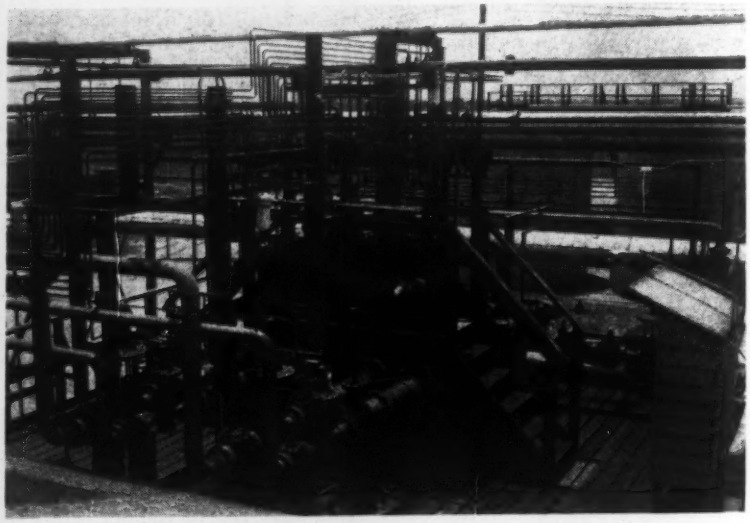


Fig. 8

It is very evident that the chemical control systems developed for this process are essential to its economical operation and have contributed greatly to the science of chemical process control.

ISA Employment Service

(Continued from page 963)

SALES ENGINEER familiar with general automatic control applications and acquainted with Eastern engineering companies to manage Eastern territory sales for large control equipment manufacture. Salary and Commission. Location New York. Box 81.

MECHANICAL ENGINEER for research laboratory. Graduate having design experience with control instruments used in the process industries. Must have creative energy and ability to follow through on different phases of instrument design. Location outside of New York City. Box 82.

A Technique For Estimating Precision of Measurement *

By FRED TROWBRIDGE (Quality Control Engineer, Sentinel Radio Corporation, Evanston, Ill.)

IF a series of measurements of a given characteristic are made on a single object, each successive measurement will, in general, differ from all the other measurements in the series (i.e., no two measurements will be exactly alike) provided the measuring instrument possesses sufficient sensitivity to indicate these differences. It follows that any one measurement may therefore be considered only as an estimate of the true measure of the characteristic in question. This true measure may be thought of as the limiting value approached by the average of a series of measurements, as the number of measurements is increased indefinitely.

Obviously, in the strict sense, this true measure can never be known exactly, and for this very reason, it is desirable to know within what limits of error a single measurement may be taken as representing the true measure of the characteristic. This computed value will be referred to as the "Total Error of Measurement," and has the significance that in practically all cases (theoretically in the order of 99.7%) a single measurement will not differ from the true measure by more than this amount.

This method consists of arranging an experiment in which five separate pieces, or units of product, are each measured five separate times; thus obtaining a set of 25 measurements. The separate pieces will be referred to as "units," and the successive measurements on each piece as "trials." All five units in each trial must be measured before proceeding to the next trial.

The following example will illustrate the procedure, and is the record of an actual case where five different inspectors, using the same micrometer-caliper, measured the outside diameter of each of five brass screw-machine bushings. Measurements were made to the nearest 1/10,000-inch, and were recorded in thousandths (i.e.: 0.3750 inch was recorded as 375.0).

TRIALS
(In this example, each with a different inspector)

Units	I	II	III	IV	V	Unit Ranges
A...	376.7*	377.0*	376.9	376.8	377.0	0.3
B...	374.7	374.7	374.7	374.7*	374.6*	0.1
C...	375.0*	375.2*	375.1	375.1	375.1	0.2
D...	376.0	376.0*	375.9*	375.9	375.9	0.1*
E...	375.0*	375.5*	375.4	375.3	375.3	0.5*

Average Range $= \overline{R} = 0.24$

The difference between the largest and smallest measurement made on each unit (those identified with asterisks in the above example) is entered in the column headed "Unit Ranges."

The average of the five unit ranges thus obtained is computed, placed at the bottom of this column, and identified as $\overline{R}$ (pronounced as "R-bar").

Before proceeding with the computation of the Total Error of Measurement, it is necessary to analyze the data thus far obtained to determine whether larger errors than may reasonably be attributed to chance variation are present. To accomplish this, two mathematical criteria, derived from statistical theory, are applied to the data. In the first of these, the ratio of the largest to the smallest of the unit ranges, (R_{max}/R_{min}), is computed, and the value of this ratio must exceed 1.4 in order for the data to be acceptable. In the above example, Unit E yielded the largest range, (0.5), and unit D the smallest, (0.1). Since the ratio of these is 5.0 therefore the critical value of 1.4 is exceeded, and the data are acceptable according to the first criterion.

The Author

Fred Trowbridge has been employed in the radio manufacturing business since 1928, and in the inspection and quality control phase of this industry since 1932, with Wells-Gardner & Co. and later with Galvin Manufacturing Corp. Since 1937 he has been with Sentinel Radio Corp of Evanston, Ill. There, as Quality Control Engineer, he has charge of all inspection, testing and production engineering activities.

To apply the second criterion, the upper limit for unit ranges is computed as 2.1 $\overline{R}$, and the value of this product must exceed the largest unit range, (R_{max}), in order for the data to be acceptable. In the example $2.1(0.24) = 0.51$, which exceeds the largest unit range of 0.5, (Unit E), and the data are acceptable according to the second criterion.

Failure of a given set of data to satisfy the first criterion can usually be traced to some assignable cause of excessive differences between trials. Such a cause may be a systematic bias in one or more of the trials. Computation of trial averages will usually reveal which trials are out of line, and the reasons may then be ascertained and corrective action taken. Failure to satisfy the second criterion will usually be due to some erratic characteristic in the measurement set-up. These two criteria have been so adjusted that the chances are very small (in the order of 3 or so in 1,000) that a set of data containing only normal chance variation will fail to satisfy them. Therefore, failure to satisfy either of them in any given case constitutes strong inferential evidence against the validity of the data. When this occurs, an investigation should be made to eliminate the sources of excessive error, and new data gathered after corrections have been put into effect.

If the data satisfy both of these criteria, then the Total Error of Measurement is computed simply as 1.3 $\overline{R}$. In the example used, $1.3(0.24) = 0.31$, or about 3/10,000 inch. Therefore, the conclusion is reached that, in practically all cases, a single measurement made by a member of this group of inspectors, under conditions similar to those existing in the experiment, will not be in error by more than about 3/10,000 inch.

It is important in using this technique to understand that it is merely a method of evaluating the precision of a measuring set-up. For this purpose precision is taken to mean the consistent reproducibility of measurement, irrespective of whether the absolute accuracy of those measurements is good or bad. Most production measurements are made on some sort of a comparative basis with respect to a standard, quite often in terms of arbitrary units that have no direct relationship to the absolute unit of measurement applicable in the particular case. In such situations the problem is almost wholly one of precision, or reproducibility.

It will be recalled that in the example presented in this paper a deliberate opportunity for variation was introduced by using different people in each of the five trials. It is, of course, possible to perform the same experiment using only one person, but the interpretation then becomes slightly different. In using one person, the Total Error, as computed, then applies to that one individual, whereas by using a group of persons, the result then applies more nearly to what can be expected from different people. There are a number of ways in which this introduction of deliberate variation may be utilized. One of these is to spread the trials over some period of time, such as one day, in order to pick up variations introduced by changing ambient conditions, etc.

The value of this technique lies not so much in the exact determination of error, as it does in promoting a systematic approach to the problem of measurement error. Cases have been observed where the measurement error was found to be greater than the tolerance to which the product was supposedly being held. Obviously, in such cases, all measurements of this sort are a waste of time and money, as they reflect variability in measurement rather than variability in product.

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

President's Report

(Continued from page 955)

any disintegrating force and the presence only of strong forces tending to hold us together. It will become increasingly evident that the birth of our Society was, in common vernacular, a "natural." This was clear in the beginning to such pioneers as Dick Rimbach and Mal Behar. From here on we must expand our natural activities to many fields of science and industry. We must build up our cooperation with institutions of scientific research, both public and private, and become more active in the major divisions of industry, such as the metals, ceramics, paper and textiles fields, while we intensify our interests in the chemical and oil industries.

Some day, not too far hence, we will meet problems of further organization into various divisions because of the crystallization of special interests, but we need not fear in the least any threat of disintegration on this account. Other societies have successfully met such problems, and we should well be able to do likewise. We may even succeed in inducting into our Society special groups who are now organized, because they will find that we can help them both financially and technically.

To do all these things we need not only the financial prosperity to which our well-managed Exhibits contribute significantly, and which will grow with our membership, but we need also a good organization filled with members who have the good of the Society at heart and are in a position to contribute their efforts in a smoothly running Society. Many of the rough spots of our organization have been remedied during the year, and the way has been prepared for further improvements in this respect. While strong emphasis must be directed especially to our Education, Publications, and Recommended Practices Committees, I believe that our new National Defense Committee will grow rapidly in importance. This seems to be indicated by current world events, and our Society might well plan to be ready to make its contribution of effort in any national emergency. The members of the Instrument Society of America will grow to learn that they represent a powerful key group in American industry and that it is highly essential that ISA be organized for well-coordinated efforts in times of stress.

ISA is destined to become a great society. Many of our members show by their enthusiasm that they believe in ISA's future greatness. Some members are reasonably impatient with our progress, but it is because they are not fully informed of the work to be done and in progress. Therefore, we need more publicity directed to our own members so that all of them will become proud of their membership. Our good editor, Bob Proctor, cannot continue much longer to serve us in this capacity, and we have the problem of finding another man to take his place. It is a real problem in our current financial condition to get our editorial work done. Some of this is in the hands of the Publications Committee, under the chairmanship of Ralph Munch, but we must have an editor who will have the time to address the Society frequently with inspiring information and to familiarize the members with the Society's activities.

I have enjoyed a year of work for the Society, and while this has been an added burden depriving me of much recreation, I firmly believe that the effort has been well spent. My enjoyment has come from association with men of fine character and high ideals, and from the contemplation of the future of our Society. I am sure that this will be in good hands for another year and that even greater progress will be made in 1948.

—C. O. FAIRCHILD

Editor's Notes

1. NEW FEATURES TO COME

We have had in past months several requests to add certain departments, change others with a view toward improving their usefulness, etc. Hoping to please the greatest number of our readers, we are accepting those suggestions which seem to occur most frequently and which are, in our opinion, most practicable. Here are the features or changes most in demand in the order of their popularity:

A. Run more technical papers in the JOURNAL. This we will attempt to do, starting with this issue. It will be our aim to have at least one complete paper in each issue, and to so schedule these papers that succeeding issues will run papers on different subjects—i.e., in different fields.

B. Cut down on Section News material. Besides being requested, this will be almost a necessity in order to carry out (A) above. Section News reports should be limited in the future to the time and place of the meeting, the speaker, the subject and a short paragraph (abstract) covering the talk. Other newsworthy items should be sent in, of course, but held to minimum of words. Some of the material formerly included in Section News reports will logically fit in the new departments to be started (C and D below).

C. Start a *Personals* Department. This department to serve as the outlet for news of promotions, deaths, transfers, etc. of prominent men of the Society who are of news value to the majority of the membership. We are starting such a department this month, with the intention of maintaining it as long as sufficient material of the right caliber can be obtained.

D. Re-establish the Calendar of Events. This was discontinued a year ago in favor of making all announcements in the Section News department. However, the calendar had its advantages, particularly in regard to the type of meeting to be held and because it was always easy for a Section Secretary to fill out the blanks on a ready-to-mail post card and drop it in the mail box each month. It is our intention to re-establish the calendar as soon as cards can be prepared and instructions sent out. This may take a couple of months, so we are tentatively scheduling the start of this feature for the January issue of the JOURNAL.

E. Maintain an up-to-date running list of all Section Secretaries and Delegates. This is at the present time, we believe, a little on the impractical side. Granted, it would be convenient for all members, and particularly for prospective members, to be able to open any issue of the JOURNAL and find the name of the Secretary or Delegate of the Section they are interested in. Someday such a listing may be essential, but at present we are offering only a compromise solution. We are scheduling such a list, to include Secretaries, Delegates and JOURNAL Correspondents, for the December issue, with possibly another one next March or April. To insure that the December listing will be as correct as it is possible to make it, *we are requesting all Section Secretaries to send us the names and addresses of their Delegates, Secretaries and Correspondents* by November 10, 1947, if they have not already done so within the past three or four months.

F. Run abstracts of articles and book reviews of current literature of interest to instrument-minded people. This is being investigated by the Publications Committee and others, and will be scheduled for consideration at a future meeting of the committee. At present nothing is contemplated along this line.

As a final thought in this series of projected improvements, and as a reminder that letters to the Editor are more than welcome, what are your suggestions for improving the JOURNAL?

2. WHO'S WHO IN THIS ISSUE

Our "Who's Who" department this month features, first of all (and properly so), our newly elected President, P. Exline, Section Engineer, Gulf Research & Development Company, Pittsburgh, Penna. Sharing the column with Paul is one of our first two-year Vice-Presidents, Herb Barnum, founder and owner of the H. H. Barnum Company of Detroit.

Also honored this time are Oliver Boutros of the Boutros Instrument Laboratories in Kansas City, who is current President and Delegate of the Kansas City Section, and another sub-committee chairman from Fred Trapnell's Recommended Practices Committee — Dave Hostedler, Project Engineer with Foster Wheeler in New York, who is in charge of sub-committee RP-5 on Instrumentation Flow Plan Symbols.

General News

HIGHLIGHTS OF 1947 CONFERENCE

From the highly successful Second Annual Instrument Conference and Exhibit held at the Stevens Hotel in Chicago, September 8-12, come the following facts, figures, pictures and other items of general interest.

1. Facts and Figures

Total registration for the week—over 7000.

Size of Exhibit—12,919 square feet of space, 147 booths, 139 exhibitors with approximately 650 men manning the exhibits.

Value of instruments and equipment on display—$6,000,000.

2. A.S.M.E. Program

The Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers, meeting jointly with the I.S.A. during the first two days of the Conference, sponsored two technical sessions at which the following papers were presented:

"Application of Mechanical Cascade Control Systems" by J. N. Swarr, Corn Products Refining Co., Argo, Ill; "Floating Scale Manometers" by W. D. Wood, Taylor Instrument Companies, Rochester, N. Y.; "Design of Instrument Gears" by G. L. Kuntny, Brown Instrument Co., Philadelphia, Pa.; "A New System of Humidity Measurement" by W. F. Hickes, The Foxboro Co., Foxboro, Mass.; and "Various Mechanical and Electrical Digital Calculators and Their Uses" by W. J. Eckert, Watson Scientific Computing Lab., Columbia University, New York, N. Y.

At the A.S.M.E. Banquet on Monday night at the Congress Hotel, J. C. Peters, Chairman of the I.I.R.D., presided. Following an address of welcome by A.S.M.E. President Eugene W. O'Brien, the guest speaker, Mr. W. Julian King, Director of the Sibley School of Mechanical Engineering of Cornell University, Ithaca, New York, presented a very interesting talk on "Personal and Professional Problems of Engineers—Aids and Barriers to Advancement."

3. I.S.A. Banquet

Approximately 500 persons, including wives and guests, enjoyed the annual I.S.A. Banquet on Wednesday evening in the Grand Ball Room of the Stevens Hotel. Chairman of the Meetings Committee A. Sperry presided. Following the introduction of the newly-elected officers by retiring President C. O. Fairchild, Executive Secretary Richard Rimbach formally presented Section Charters to the delegates or other representatives of the 34 Sections of the Society. An I.S.A. Banner bearing the new emblem of the Society was presented to the Philadelphia Section for having the most members (29) at the banquet. (The Chicago Section was, for obvious reasons, excluded from this impromptu contest.)

The guest speaker of the evening was Dr. J. T. Rettaliata, of the Illinois Institute of Technology, who spoke on "Jet Propulsion." His talk was up-to-date and extremely interesting, and was profusely illustrated by excellent slides.

Dinner music, three portable bars open for business in the ballroom foyer, and dancing for several hours after the meeting all contributed to the success and enjoyment of the banquet.

4. Foreign Visitors Honored at Luncheon

Approximately 40 foreign visitors to the Conference, representing 12 countries, were honored at a luncheon in the Boulevard Room of the Stevens Hotel on Wednesday, Sept. 10. Al Sperry, Chairman of the Meet-

I.S.A. Banquet

ings Committee, presided and introduced the guests.

Countries represented at the luncheon were Norway, Sweden, Czechoslovakia, Holland, Belgium, France, Spain, Switzerland, Netherlands West Indies, England, Russia and Canada. Also registered for the Conference, but not present at the luncheon, were representatives from China, Australia and Brazil.

5. 200 Take Plant Trips

Chairman J. N. Swarr of the Plant Trips Committee reports that of the three plant trips arranged by the committee, two were filled to capacity. The trip through Central Scientific Company Thursday afternoon was made by almost 50 persons, the limit set by the company. On Friday afternoon, the inspection trip through the Standard Oil Company Refinery in Whiting was taken by approximately 100 persons, which was the limit set for that trip. The trip through South Works of Carnegie-Illinois Steel Corp., also with a 100-person limit, attracted 50-some visitors Friday afternoon.

6. Akins Audience Sets Record

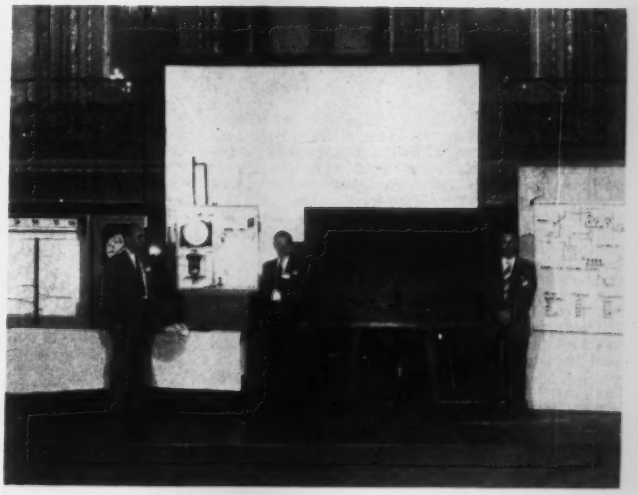
The record for attendance at any technical or educational session of the Conference was set Wednesday morning Sept. 10 when nearly 1000 persons gathered in the Grand Ballroom of the Stevens Hotel to hear G. F. "Jerry" Akins explain Automatic Control Principles with the aid of a considerable quantity of specially made demonstration equipment. Aided by Mr. John Kowalski, also of Eastman Kodak Co., Jerry staged a repeat performance of his presentation which was the high spot of the Pittsburgh Conference last year. The demonstration equipment was greatly improved this year by the addition of a specially-built 30-inch pneumatically-actuated strip chart recorder which plotted a record easily seen by everyone in the audience. Those who missed this demonstration missed (in this reporter's humble opinion) one of the high spots of the 1947 Conference.

7. Servomechanism Symposium Popular

While all the technical sessions of the Conference were well attended, the Tuesday evening "Servomechanism Symposium" drew the second-largest audience of the week, exceeded only by the audience at Jerry Akins' demonstration lecture Wednesday morning. The Servomechanism Symposium, featuring Professor Don Campbell of M.I.T., was also highlighted by an impressive array of demonstration equipment. Dr. Campbell, in his discussion of "Practical Applications of Automatic Control Theory," demonstrated the equipment developed at M.I.T. for analyzing the performance characteristics of a closed-loop servo system. Part of his equipment consisted of a 20-inch cathode-ray oscilloscope, the screen and patterns of which were clearly visible to every one of the several hundred persons present. The rest of the apparatus, consisting of synchro-generators, synchro-motors, control transformers, amplifiers, etc. was used to analyze and predict servo system performance in applications to specific problems.

This session developed probably the most highly theoretical discussion period of the

General Views of ISA Exhibit



Views of Akins and Kowalski Demonstration of Control Principles

Conference as the Automatic Control experts and theorists started throwing in their problems and observations during the second half of the meeting. Professor Dick Jones of Northwestern, technical chairman of the evening, deserves much credit for his admirable handling of the program.

8. Haring Reelected

At a meeting of the representatives of the exhibitors at the Conference, Warren F. Haring, Wallace & Tiernan Products Inc., Belleville, N. J., was re-elected chairman of the Exhibitors' Advisory Committee for 1948. This committee, which functioned so smoothly and contributed greatly to the success of the 1947 Exhibit, serves as an outlet for the views of the exhibitors and manufacturers of instruments in matters pertaining to the exhibit each year. It is expected that the work of this committee will be even more valuable in the preparations already under way for the 1948 Conference and Exhibit in Philadelphia next September.

Official News

Summary of Employment Committee Report

(Presented before the Annual Meeting of the Society on Monday, September 8, 1947, at the Stevens Hotel, Chicago, Ill., by C. F. Goldcamp, Chairman of the Employment Committee)

The following summary as of September 1 will serve to show the overall activities of the Employment Committee since its formation in October, 1946.

EMPLOYMENT SERVICE REGISTERED APPLICANTS:	
Class A—Graduates of Technical Institutions	108
Class B—Instrument Technicians and Mechanics	137
Class C—Student Registrants	11
Class D—Miscellaneous Applicants	52
Total, all applicants, all classes	308
REGISTERED OPEN POSITIONS:	
Open positions announced in the JOURNAL of the I.S.A.	72
Open positions referred to the Employment Committee but not announced in the JOURNAL of the I.S.A.	10
Total open positions	82
APPLICATIONS RECEIVED FOR OPEN POSITIONS and forwarded to the prospective employers	354
OPEN POSITIONS FILLED from applications through the Employment Committee	22

This last figure, we believe, is the most significant—22 positions filled of the total of 82 listed with the Committee, or 26.8%. We of the Committee believe this figure represents a fair performance for a young society in view of the efforts made to fill the same positions through paid advertisements in other publications, and through the personnel departments of the various employing manufacturers. Even better results can be expected in the future as more of the Sections get their local Employment Committees into action. Of the thirty Sections in existence as of May 1, 1947, only thirteen had formed local Employment Committees and had representation on the National Employment Committee. One of the immediate aims of the National Employment Committee is to encourage the formation of, and cooperate in the activities of local Employment Committees in those Sections not already having such committees.

A report on the activities and results of the Employment Register operated at the Chicago Conference will be released as soon as the information obtained therefrom can be analyzed and tabulated.

—C. F. Goldcamp, *Chairman.*

Membership Committee Report

(Presented before the Annual Meeting of the Society on Monday, September 8, 1947, at the Stevens Hotel, Chicago, Ill., by Richard Rimbach, Chairman of the Membership Committee.)

To make the report of the Membership Committee brief and still complete, we have listed below the increase in the various grades since August, 1946 (one month before the First Annual Conference and Exhibit in Pittsburgh), up to August, 1947.

Since August, 1946, the Society membership has increased from 1075 to 2296, an increase of 1221, or 110%. During this period of 12 months, the number of Sections increased from 21 to 32. (ED. NOTE: Since this report was written, two more Sections—Sarnia and Tulsa—have been added.)

There are still six local instrument societies in existence, with a total membership of about 600, which are not Sections of the I.S.A. During the next 12 months a very special effort will be made to bring these groups into the fold. There are also about a dozen groups being organized, but as yet no formal organization has been established.

In the period covered by this report, only 60 members were lost by resignation and one by death.

With the services now being furnished to the membership rapidly increasing, and as these services will shortly exceed in value the dues paid by the member, the one question which has plagued the effort to obtain new members can soon be answered with specific figures.

It is our hope that local Membership Committees, as well as individual members, will now be spurred on to double the I.S.A. membership in the next twelve months.

	Members	Associate Members	Student Members	Total
August 1946	884	190	1	1075
September 1946	1018	190	1	1209
December 1946	1412	223	5	1640
April 1947	1758	358	5	2121
August 1947	1835	435	26	2296

The membership by Sections as of August 1, 1947, is as follows:

Section	Members	Associate Members	Student Members	Total
Aruba	25	3	—	28
Baltimore	59	1	—	60
California	43	4	—	47
Central Indiana	9	72	—	81
Charleston	78	13	—	91
Chicago	211	22	12	245
Cincinnati	41	1	1	43
Cleveland	113	6	—	119
Cumberland	22	9	—	31
Detroit	80	3	—	83
Eastern New York	17	—	1	18
Gulf Coast	12	15	1	28
Kansas City	24	14	—	38
Louisville	51	2	—	53
New Jersey	145	1	—	146
New Orleans	8	1	—	9
New York	128	4	—	132
Niagara Frontier*	40	8	—	48
Northern Indiana	2	19	—	21
Oak Ridge	69	—	—	69
Ontario	61	—	—	61
Philadelphia	205	51	7	263
Pittsburgh	141	15	1	157
Presque Isle*	1	1	—	2
St. Louis	79	—	—	79
South Bend	7	20	—	27
Southern Michigan	32	16	3	51
South Texas	37	13	—	50
Tennessee	12	11	—	23
Twin Cities*	8	3	—	11
Washington	46	95	—	141
Wayne County	29	12	—	41
TOTALS	1835	435	26	2296

*Not all members of these new Sections have as yet paid up their membership dues. The numbers listed above indicate only how many had paid as of the date of this report. The number of members in these Sections who have just been invoiced, and the increase in Section strength when all are paid up, is shown as follows:

Niagara Frontier—
66M and 14AM; increase will be 32
Presque Isle—
14M and 4AM; increase will be 16
Twin Cities—
10M and 17AM; increase will be 16
Total increase in above grand total 64

Resignations from August 1946 to August 1947	60
Deaths between 1946 and August 1947	1
Number in arrears for dues as of August 1947	176

—Richard Rimbach, *Chairman*

Recommended Practices Committee Report to Board of Directors

(Following is a summary of, and excerpts from, the annual report of the Recommended Practices Committee as presented by Chairman F. H. Trapnell at the Board Meeting in Chicago on Sept. 6, 1947.)

At the meeting of this committee in April 23d in Cleveland, it was predicted that approximately twelve specific projects could be gotten under way in time to assure tentative or preliminary release of at least half of that number by the end of the year. It has now become apparent that this prediction will not be met. Undoubtedly twelve projects will be activated before the year's end (nine being under way as of September 6th) but it is improbable that more than one can be published in 1947. The necessity for "lowering our sights" in this work to be accomplished this year results from two major factors:

1. The time required to assemble preliminary data for even those projects which appear relatively simple on the surface is much greater than originally estimated. A great deal more research and preparation time than was first anticipated is required before firm recommendations can be submitted by the sub-committees for consideration by the main committee and others who will review and approve the results prior to release.

2. In the meeting of April 23d at Cleveland, the members present went on record as being definitely unfavorable toward any plans for *tentative* issues of recommended practices immediately after review by the main committee or a group selected by the committee. Without question, this action was wisely taken and although more time will be required to bring material to the stage of publication, it will guard against the possibility of issuing any work which might bring I.S.A. unfavorable publicity.

A committee has been appointed, and is now at work, under the chairmanship of W. A. Wildhack, to draft a specific procedure by which the work of any sub-committee of the Recommended Practices Committee will be given consideration by the main committee and by others before being officially released. In fact, the procedure will probably prohibit the release of tentative practices, and it is now felt that such action would be entirely justifiable.

Other items brought up at the April 23d meeting and acted upon since are as follows:

1. A report covering standard pneumatic controller and transmission pressure ranges tentively agreed upon by the manufacturers was read by Mr. Anker E. Krogh, liaison member representing S.A.M.A., and given unanimous approval. This action was formally transmitted to S.A.M.A. through Mr. Krogh and will become a part of the work to be issued in connection with "Recommended Practices for Pneumatic Transmission and Controller Usages" being prepared by sub-committee RP-6 under the chairmanship of Mr. J. G. Kerley.

2. It was resolved that committee membership should be increased, that new members should represent industries other than those already represented on the committee, and that additional liaison members should be appointed to represent other societies.

3. The committee set up, and money was appropriated by the Board of Directors for a loose-leaf binder system, such binders to be issued to the membership and to include a section devoted to Recommended Practices Committee issues and reports. The binders are now on order. (Samples were shown at this meeting.—ED.)

4. The suggestion that reprints of already accepted standards or other technical data be furnished with the binder awaits further action by the committee and by the Board of Directors.

5. The list of sub-committees which are now active is as follows:

RP-1 Thermocouple and Extension Wire Standards; Chairman, H. M. McCarthy.
RP-2 Manometer Tables; Chairman, W. G. Brombacher.
RP-3 Flowmeter Installation Practices; Chairman, R. L. Galley.
RP-4 Control Valve and By-Pass Installations; Chairman, W. H. Fortney.
RP-5 Flow Plan Symbols; Chairman, David E. Hostedler.
RP-6 Recommended Practices for Pneumatic Transmission and Controller Usages; Chairman, J. G. Kerley.
RP-7 Pneumatic Control Circuit Pressure Tests; Chairman, S. C. Chapman (Aruba Section).
RP-8 Outside Instrument Protective Cabinets; Chairman, W. A. Crawford.
RP-9 Instrument Tubing Supports; Chairman, J. Johnston, Jr.

6. The committee's request for a paid Executive Secretary to handle the rapidly increasing detail work of the committee awaits further action by the Board of Directors

—F. H. TRAPNELL, *Chairman*

BOARD OF DIRECTORS MEETING HELD IN CHICAGO SEPT. 6TH

On Saturday, September 6, 1947, two days before the opening of the Second Annual Instrument Conference and Exhibit in Chicago, the Board of Directors of the I.S.A. held its annual meeting for the purpose of electing three new officers (president and two vice-presidents) and transacting other business which is normally handled at the annual Board meeting.

Twenty-one Sections were represented as the roll was called, representing 1921 votes out of the total voting strength of the Society of 2270. Among the items of business transacted and actions taken, the following highlighted the meeting:

1. Roll Call.
2. Reports of Standing and Special Committees.
3. Acceptance of and/or actions on committee reports.
4. Secretary's report on progress of arrangements for 1948 Conference and Exhibit in Philadelphia.
5. Presentation of bids for 1949 Conference and Exhibit by Cleveland and St. Louis.
6. Election of new officers.

Under item 2, those reports of special interest to the members are published elsewhere in this issue, as are the results of the election of officers (item 6).

Item 4 was covered by a brief report by Executive Secretary Rimbach to the effect that 20,580 square feet of space have been laid out in 185 booths in Convention Hall in Philadelphia for the 1948 Conference and Exhibit there next September 13-17. Eight of these spaces are to be reserved for government exhibits. (In comparison, the Chicago Exhibit consisted of 147 booths totalling 12,919 square feet, with government exhibit occupying 4 booths.) According to Mr. Rimbach, we are again assured of the cooperation of the Industrial Instruments and Regulators Division of A.S.M.E. at the Philadelphia Conference, with the probability that the American Institute of Physics will collaborate by holding a symposium on scientific instruments at that time.

Item 5 consisted of two very excellent presentations designed to secure the votes of the delegates in choosing the location of the 1949 Conference and Exhibit. The first bid was presented by Mr. Brennan, Vice-President of the Cleveland Convention Bureau, who was introduced by the Cleveland Section delegate, Harvey Lee. Mr. Brennan expounded the merits of Cleveland as a convention city, and described the facilities available. Following Mr. Brennan's talk, Delegate W. E. Boyle of St. Louis presented that city's invitation. Backed by letters from the Mayor, the Convention Bureau and the Hotel Association of St. Louis, Mr. Boyle explained the terms under which the Society could obtain the use of the Municipal Auditorium for the week of September 12-16, 1949, and described the facilities of the city from the "conventioneer's" point of view. When the vote was taken, St. Louis was the almost unanimous choice.

Among other items not reported elsewhere in this issue was the vote of acceptance on Tulsa's application for a charter as the 34th Section of the Society.

A late action, which really falls under item 6 above, was the appointment (by Board action) of the two retiring Vice-Presidents, J. B. McMahon and R. H. Munch, to the Executive Committee.

—RRP

To All Section Secretaries

The following changes should be made in your listing of Section Secretaries, Delegates and JOURNAL Correspondents:

Detroit—Secretary, J. W. Head, Industrial Electronics, Inc., 21 Henry St., Detroit 1, Mich.

Eastern New York—Delegate, George F. Gardner, 408 Charles St., Scotia 2, N. Y.

South Bend—Secretary, George Gilliam, Brown Instrument Co., 225 Christman Bldg., South Bend, Ind.; Delegate, J. G. Buck, Ass't Professor, University of Notre Dame, Notre Dame, Ind.; JOURNAL Correspondent, Marius Wolf, 2012 Homewood St., Mishawaka, Ind.

Section News

ARUBA

Acting Chairman Ed Pfeffer called our Fourteenth meeting to order at 7:20 p.m. September 7, 1947. During the half-hour business session preceding the feature talk of the evening, Program Chairman Hughes distributed copies of a paper entitled "Graphical Representation and Analysis of Automatic Control Terminology" by J. G. Horn. This paper was presented before a 1946 meeting of the ASME, and the cooperation of the Brown Instrument Company in sending us enough copies for all members is much appreciated.

Our speaker for the evening was Mr. Howard Daudet, former Chief Engineer of the combined Fort Pitt Grinding Wheel Company and the Keystone Abrasive Wheel Works of Pittsburgh. The subject of his talk was "The Process for the Manufacture of Grinding Wheels." The objective of the talk was to explain the process from the standpoint of its place in instrumentation and the part that instruments play in the process. Actual samples of the various materials and finished products of the industry were demonstrated, and methods of selecting the correct grinding wheel for any given grinding job were explained with the aid of detailed charts.

Several examples of processes used in manufacturing abrasive wheels were discussed, and the various instruments used to control these processes (including mixing, weighing, drying, baking, balancing and inspection) were described.

The talk was termed the "best yet" by those present, and Howard was heartily commended. After the talk the meeting was adjourned for refreshments, following which we viewed the color-sound film "An Engineering Reason" which was made available to us through the courtesy of the Yarnall-Waring Company of Philadelphia. The film was very well received.

After a busy and educational evening, the meeting was adjourned at 10:30 p.m.

—J. L. LOPEZ, *Corr.*

CENTRAL INDIANA

The first fall meeting of the Central Indiana Section was held at Purdue University Extension on September 3, and it was interesting to note that, though there had been no meetings during the summer months, the attendance and interest of the members at this meeting was large and gratifying.

Mr. G. N. Burkhart from the Engineering Department of the Duncan Electric Manufacturing Company gave a very interesting and instructive talk on "The Application of Integrating and Demand Meters." To illustrate his talk Mr. Burkhart passed around to the members various parts of watt-hour meters, calling attention to the various ways these instruments had been constructed to meet the needs of their various fields of application.

Copies of the news letter of the Aruba Section (The ISA Bulletin) were passed around to the members by Morris Underwood, Secretary-Treasurer and Delegate of the Central Indiana Section. Those reading over the Bulletins were impressed by the interest and rapid growth of the I.S.A. which they gave evidence of.

Program Chairman G. A. Rutledge announced the following schedule for the remainder of this year:

Tuesday, October 7—Mr. James F. Inman of Associated Research, Inc., Chicago, Ill., will talk on "The Keeler Polygraph."

Tuesday, November 4—Mr. H. C. Frost, Corn Products Refining Company, Argo, Ill., and newly-elected Vice-President of I.S.A., will present a talk entitled "Instrumenting a Continuous Chemical Process."

Tuesday, December 2—Mr. A. J. Corson, Instrument Development Section, General Electric Company, will give a talk on "The Development and Application of Concentric Scale Instruments." Mr. Corson expects to keep the talk informal and illustrate applications with lantern slides.

—M. W. HANSON, *Corr.*

CHICAGO

Because of the Second National Instrument Conference and Exhibit held in Chicago during the week of September 8-12, no regular meeting of the Chicago Section was scheduled for September.

The next meeting is to be a joint meeting with the Northern Indiana Section at Phil Schmit's in Hammond, Indiana, on Monday, October 6. The speaker is to be Dr. Donald J. Bergman, Chief Engineer of Universal Oil Products Co., Chicago, who will speak on "A New Technique in Instrumentation—the Fluid Cat Cracker."

The program for the balance of 1947 is as follows:

Monday, November 3, Picadilly Restaurant, Chicago—"Radiosondes" by Mr. V. D. Hauck, Chief Engineer, Friez Instrument Division of Bendix Aviation Corporation.

Monday, December 8, Builders Club, Chicago—"A Non-Mathematical Discussion of Flow Metering" By Mr. J. B. McMahon, Republic Flow Meters Company, Chicago.

—SYLVIA MAE DUSHKES, *Corr.*

DETROIT

1947 Meeting Schedule:

September—Wm. F. Swann, Eastman Kodak Company, "The Role of Photography in Industry"; R. R. Proctor, The Pure Oil Research and Development Laboratories, "The Electronic Spark Advance Indicator."

October—Wesley Erwin, General Motors Research, "Supersonics as Applied to Non-Destructive Testing"; and M. Peck, Cities Service Co., "Exhaust Gas Analysis."

November—Harry F. Moore, Standard Oil Co., "Organization of an Instrument Department."

December — M. Good, Diamond Power Specialties, "Practical Television in Industry."

—W. E. WILSON, *Corr.*

WAYNE COUNTY

The first meeting of the season was held September 15th at the Presbyterian Church House in Wyandotte, with dinner at 6:30 and the program at 8:00 p. m. The dinner hour was enlivened by an accordionist and some group singing.

The Section's official charter, received at the annual banquet during the Conference in Chicago the previous week, was presented by our Delegate, Bill Baker, and was accepted with great appreciation. Followed then several reports on the Conference and Exhibit in Chicago, and announcements of coming meetings in our own and the Detroit Sections.

The Program Chairman, Russell Cushing, showed three very interesting films to complete the program for the evening. The first, "East Lynn," showed the history and present manufacture of the G-E Watthour Meter. The next was a General Motors film, "Sand and Flame" and covered the manufacture of glass, including plate glass and shatter-proof safety glass. The last was a General Motors film entitled "Magic in the Air," being a story on Television.

—JOHN MACPHERSON, *Acting Corr.*

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA 1117 Wolfendale St., Pittsburgh 12, Pa.

INSTRUMENT MECHANIC thoroughly familiar with maintenance of oil refinery instrumentation. Rate, $1.33 per hour plus 23.83c cost of living bonus. Forty hours per week daylight, subject to call-out during the night and twelve hours per day during clean-out periods. Location Kansas. Box 76.

SALES ENGINEER for calling on industrial plants, heating and air conditioning contractors, architects, etc.; doing sales work on automatic control systems. Must be graduate with degree in M.E. or equivalent and not over thirty years of age. Excellent opportunity for promotion, as company is expanding. Starting salary $250 per month; five day week; two-week vacation after one year; free life, health, accident, hospital and surgical insurance. Location Chicago, Ill. Box 77.

INSTRUMENT ENGINEERS (Three) for manufacturing research division of large machinery manufacturer. Requirements, B. S. degree (minimum) with six years experience in instrument field and some metallurgical experience. Must be able to make measurements of physical values by electrical, etc. means. Location near Chicago, Ill. Box 78.

MECHANICAL ENGINEERS by the Scientific Personnel Division, Office Naval research for positions in various Navy research laboratories located throughout the United States. Salaries range fom $2644 to $9975 per year. Box 79.

JUNIOR DRAFTSMAN for detail drafting on valves and liquid level controls. Location Chicago, Ill. Box 80.

(Continued on page 958)

PINS MAY BE ORDERED NOW

The I.S.A. emblem, made up in the form of a gold-filled lapel button, was placed on sale for the first time at the Chicago Conference in September, at which time practically the entire initial order of 250 pins

was sold. Another lot was expected shortly (as of press time on this issue) and may be secured by writing the Executive Secretary, Richard Rimbach, at the National Office, 1117 Wolfendale Street, Pittsburgh 12, Penna. The price is $1.50, postpaid.

Who's Who in the I.S.A.

PAUL G. EXLINE
(President)

The Instrument Society of America is fortunate in having at the helm for the coming year a man well known for his ability and experience in technical society and organizational work. Newly-elected Paul Exline has been an active participant for many years in such organizations as the American Society of Mechanical Engineers, the American Society for the Advancement of Science, Sigma Xi, the Physical Society of Pittsburgh, and the American Society for Measurement and Control both before and since it became the Pittsburgh Section of the I.S.A. He has been a pillar of dependability and a mar of intense activity in the I.S.A. ever since its early organization days, and well deserves the honor just bestowed upon him.

Paul was born in Midvale, Ohio, April 18, 1903. He graduated from McKinley High School in Canton, Ohio, in 1921, and immediately entered Mount Union College at Alliance, Ohio. Taking one year out for teaching near Canton, and another year as Principal at Robertsville, Paul was graduated from Mount Union in 1927 with a B.S. degree. Entering, the University of Pittsburgh to continue his studies in Physics, he emerged with his M.S. in 1933 after a short detour of one year at Johns Hopkins University in 1932. During these years he served as Fellowship Assistant (1927-28) and then as Fellow (1928-32) at Mellon Institute of Industrial Research in Pittsburgh where he specialized in Instrument research and development.

In 1933, Paul joined Gulf Research and Development Company, where he is at present Section Engineer in charge of design, development and supervision of specialized lubrication test equipment, instruments and controls. The list of projects he has directed to successful conclusion would fill many pages. Suffice it to say that he holds several patents (both solely and jointly) on testing and recording apparatus, and that he is the author or co-author of over a score of technical articles and papers, some of which have been presented at national I.S.A. meetings.

Paul has served in the various offices and on most committees of the Pittsburgh Section, and was Chairman of the Exhibit Committee for the 1946 Conference and Exhibit held in Pittsburgh in September of last year. The success of this venture, the first of its kind for I.S.A., was due in no small measure to Paul's untiring efforts over a period of nearly two years preceding the actual event.

Paul is also a Registered Professional Engineer in the state of Pennsylvania. His home is in Verona, Pa., where, in his spare time (?), he shares his hobbies of photography and music (via phonograph records, he says) with his wife, Ruth, and their three sons—John, 18; James, 13; and Peter, approximately 2.

HERBERT H. BARNUM
(Vice-President)

"Herb" Barnum, Detroit Section, is starting the second year of his two-year term as one of the Vice-Presidents of I.S.A., to which office he was elected in September 1946 at the Pittsburgh Conference. Herb was born January 6, 1916. He attended Michigan State College and the University of Illinois, studying Mechanical Engineering, and started his professional career in 1940 with Brown Instrument Company.

In 1946 Herb left Brown to set up his own office in Detroit as a Contracting Engineer and Engineering Sales Representative. He is a member of ASM and the Engineering Society of Detroit, and during the formative years of the I.S.A. served as Delegate for the Detroit Section. He is at present a member of the Sections Committee of the I.S.A.

Herb's hobbies are of the typical busman's holiday type—the Study of Human Engineering and Automatic Control Theory.

OLIVER L. BOUTROS
(Delegate, Kansas City Section)

One of the most active men in the Kansas City Section is Oliver Boutros, who is this year serving as both President and Delegate of that group. Born December 11, 1909 in St. Louis, Mo., Oliver progressed through high school and into college where he majored in mathematics. He took up radio as a hobby in 1922 and has stuck more or less to that phase of engineering ever since. From 1925 to 1932 he worked at it commercially, and began instrument work—particularly in the field of Electrical measurements — as a hobby in 1925.

Concurrent with his radio work, Oliver set up his own business in 1934 designing, custom-building and maintaining electrical and electronic measuring instruments, and has built the venture up to a fair-sized business today.

Oliver is married and has two boys, 6 and 12 years old. He lists his wife as one of his greatest assets in his business inasmuch as she enjoys working on instruments as much as he does. She also shares with him his hobbies—photography and machine shop work.

I.S.A. work is another of Oliver's hobbies. He has served the Kansas City Section as Secretary (1946), Delegate (1946-48) and President (1947-48), besides having served on most of the local committees at one time or another.

DAVID E. HOSTEDLER
(Chairman of Sub-committee RP-5, of Recommended Practices Committee, on "Instrumentation Flow Plan Symbols)

Dave Hostedler is another one of those men who studied one thing and ended up in another field, which only goes to prove more or less to some people's satisfaction that Instrument Engineers are born, not made. Dave was born in August, 1909, in the hills of West Virginia. At an early age he moved, with his family, to Delaware where he graduated from Greenwood, Del., high school in 1926. From 1926 to 1932 he attended Drexel Institute in Philadelphia, graduating as an Electrical Engineer, specialist in transmission line design. Incidentally, he says, since then he has never had occasion to design even one electrical transmission line, as he had become quite interested in instrumentation and control—the "gadgets" appealed to him much more than the high voltage.

During his college days he was employed part time in the meter department of the Philadelphia Electric Co., Thompson-Levering Co., Western Electric Co., and Brown Instrument Co. He stayed with Brown Instrument Company after graduation and until 1942, working in practically all departments and divisions and at all phases of the business, from factory repair to application engineering. The last few years (1935-42) of this period were spent in New York as a Brown representative, specializing in refinery and chemical plant instrumentation.

In 1942 Dave left Brown to go with Foster-Wheeler Corp., Petroleum Refinery Division, where he is now serving as Instrumentation Engineer, supervising all instrumentation and control design for refinery contracts. Last year he was made Project Engineer, in charge of the over-all engineering and execution of contracts for petroleum refinery units assigned to him.

Dave is married but has no children. The Hostedlers live at 81 Columbia Heights in Brooklyn, N. Y., during the winter, and at their Fire Island cottage in the summer where, as President of the Fire Island Surf Fishing Club, Dave indulges in his hobbies of fishing, boating and "tinkering" with any and all kinds of mechanical and electrical gadgets. Dave is a member of the New Jersey Section of I.S.A., and is at present hard at work gathering data for consideration and correlation by his Instrumentation Flow Plan Symbols committee.

Personals Department

Bill Boyle, Delegate from the St. Louis Section of I.S.A., has recently earned another well-deserved promotion. Shortly after our "Who's Who" write-up on Bill in the June issue of the JOURNAL he was made Senior Instrument Engineer at Shell Oil's Wood River Refinery replacing Paul Hoyt who was transferred to Shell Development Co. in San Francisco, Calif.

As Senior Instrument Engineer, Bill becomes head of a sizable group of instrument engineers, technicians and mechanics at the Wood River Refinery. The accompanying picture of Boyle and Hoyt was taken at a farewell dinner in Mr. Hoyt's honor.

Hoyt, who was head of the Wood River Refinery Instrument Department for eight years, was very active in I.S.A. affairs, and, according to Bill Boyle, intends to do what he can toward the formation of a Section in San Francisco. Boyle, of course, will remain as active as possible in I.S.A. affairs, both local and national, and will be on hand to greet us at the 1949 Conference in St. Louis. It was he who presented St. Louis' successful bid for the 1949 Conference at the meeting of the Board of Directors in Chicago on September 6th.

Bill is a member of the Recommended Practices Committee, serving on the Thermocouple Color Coding and Extension Wire Standards sub-committee, and was one of the runners-up for Vice-President in the recent national election of I.S.A. officers.

Bill Boyle Paul Hoyt

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 969.

O-477 **Monitoring Radiation Dosage.** 4-page 6" × 8" bulletin describes the week-ly film badge service for health monitoring of workers in the radio-active field. Tracerlab, 55 Oliver St., Boston 10, Mass.

O-478 **Remote Liquid Level Indicators.** 16-page Bulletin WG-1822 pictures and describes maker's line of instruments for liquid level control. Yarnall-Waring Co., Philadelphia 18, Pa.

O-479 **"Modern Precision."** 8-page 11" × 15" Vol. 7, No. 2 of this house organ covers Metals, Rock and Clay Products, Power, Process Industries, Research, Teaching and Testing. Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia 44, Pa.

O-480 **Counting Devices.** 120-page 8½" × 11" General Catalog G-47 is a collection of 15 bulletins on every type and variety of counter, introduced by a comprehensive alphabetical list of types of equipment with references to the bulletins which cover the suitable counters and show actual applications. All the information needed to order is presented on each single page on which that counter is presented. Veeder-Root, Inc., Hartford 2, Conn.

O-481 **Flowmeters for Corrosive Service.** 8-page 8½" × 11" catalog 32-F announces a complete line of flowmeters made of various corrosion-resistant materials such as porcelain, hard lead, Haveg, glass, and hard rubber. Included also are dimensional details and a section on laboratory flowmeters. Fischer & Porter Co., Dept. 5C-E, Hatboro, Pa.

O-482 **Weston Engineering Notes.** The August issue of this publication includes these articles: A New Humidity Indicator; Absolute Units Replace International Units New Year; Organizing an Electrical Instrument Standardizing Laboratory; Methods for Determination of Resistance of Power Sources. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

O-483 **Projection Lenses.** 3¼" × 6½" Special Bulletin contains a chart showing proper focal length lens to use on 16 mm. projection in order to obtain the proper picture size on the screen. Simpson Optical Mfg. Co., 3200 W. Carroll Ave., Chicago 24, Ill.

O-484 **Altimeter Setting Indicators.** 8½" × 11" Catalog Pages 911-913 describe an instrument which provides a direct and continuous indication in inches of mercury of the altimeter setting for broadcast to aircraft by airport control towers, airway control station or weather stations. Kollsman Inst. Div., Square D Company, Elmhurst, N. Y.

O-485 **Pressure-operated Switch.** 4-page 8½" × 11" Bulletin Model 310 lists the features of this device and lists a number of applications. Meletron Corp., 950 North Highland Ave., Los Angeles 38, Calif.

O-486 **Float Switches.** 2-page 8½" × 11" Bulletin 3150 covers alternating float switches and alternators. "Type HSH Floatrol" illustrated equalizes the wear on pumps by transposing the starting sequence at the beginning of each pumping cycle. Automatic Control Company, St. Paul 4, Minn.

O-487 **Electrical Indicating Instruments.** 4-page 8½" × 11" folder illustrates and list prices of ammeters, microammeters, thermal ammeters, milliammeters and voltmeters in 2½" and 3½" flush mounting round cases and in 3" and 5" square mounting case. Meters, Inc., 915 Riveria Drive, Indianapolis 5, Ind.

O-488 **Titrater.** 4-page 8½" × 11" Bulletin 204 describes the Larrabee Titrater for the electrometric detection of end points in titrations involving oxidation and reduction reactions. Burrell Technical Supply Co., 1942 Fifth Ave., Pittsburgh 19, Pa.

O-489 **Curvimeter.** 6-page 4" × 4½" leaflet illustrates an instrument which measures distance accurately by running the instrument along the lines of a blueprint or plan. Three scales: ⅛", ¼" and ½" per foot. Herman H. Sticht Co., 27 Park Place, New York, N. Y.

O-490 **Sensitive Altimeters.** Catalog pages 101-106 covers altimeters designed for use under instrument flying conditions requiring accuracy within close limits throughout wide ranges of pressures and temperatures. Kollsman Instrument Div., Square D Co., Elmhurst, N. Y.

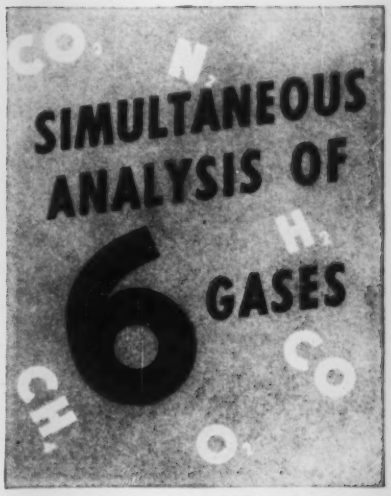
O-491 **Thickness Gage.** 6-page 8½" × 11" Sales Data Sheet No. 3700 illustrates and outlines the operation and applications of the "Reflectogage" for thickness measurement and the inspection of bond. Sperry Products, Inc., 1505 Willow Ave., Hoboken, N. J.

O-492 **Spectrophotometer.** 8-page 8½" × 11" Bulletin B-212 pictures and describes the "Coleman Model 14 Universal Spectrophotometer" and its adaptability as a photofluorometer for fluorescence measurement, as a nephelometer for measuring cultures and spinal fluid, etc., also for spectrochemical titrations and conductivity measurements. Boder Scientific Co., 719-721 Liberty Ave., Pittsburgh 22, Pa.

O-493 **Laboratory Ovens.** 2-page 8½" × 11" sales letter lists laboratory ovens with complete description and price. Boder Scientific Co., 719-721 Liberty Ave., Pittsburgh 22, Pa.

O-494 **Thermal Conductivity Units.** 4-page 8½" × 11" bulletin contains information on "Ever-Tite" thermal conductivity units for low cost gas analysis in labs, petroleum refineries, aircraft carriers, chemical and processing plants, etc. List of specifications, accessories, and prices included, along with illustrations. Gow-Mac Instrument Co., Newark 5, N. J.

O-495 **Insulation Testers' Manual.** 75-page 5" × 8" Instruction Manual 21-J offers up-to-date information on insulation resistance testing: test leads, effect of capacitance, operating time, surface leakage, and use of the "Guard" terminal. Scales and pictures are included and the principle of operation and voltage



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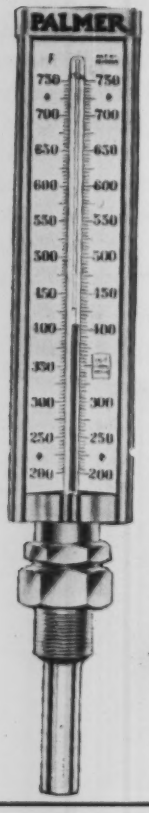

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characteristics of the "Megg[illegible]" instrument are explained. Fifty cent[illegible] per copy free of charge to those having reason to be interested. James G. Biddl[illegible] Co., 1[illegible] Arch St., Philadelphia 7, Pa.

O-496 **Electronic Relays.** 12-page 8½" × 11" Catalog No. 7 illustrate[illegible] and describes "Phil-trol" line of relay[illegible] for electronic and industrial control, signal and traffic control, radio and communication. Characteristics, contact assemblies, and dimensional drawings of each relay are included. Phillips Control Corp., 612 Michigan Ave., Chicago 11, Ill.

O-497 **Industrial and Testing Thermometers.** 4-page 3¼" × 6" Circular T-14C illustrates the general-purpose, heavy-duty and testing models of "Weston" thermometers and gives the range and standard stem lengths. E. W. Turner Electric Co., 6138-40 Beechwood St., Philadelphia 38, Pa. Box 6564.

O-498 **Rotary Hand Pumps.** 4-page 8½" × 11" Bulletin No. 3301 pictures and describes four models of maker's hand pumps and announces a new meter equipped unit built for fueling or dispensing liquids up to 10,000 S.S.U. viscosity and registering to 8 gallons. Bowser, Inc., Fort Wayne 2, Ind.

O-499 **Scaling Unit.** 8½" × 11" sheet pictures and highlights the features of "Model 161" scaling unit for both research and routine counting of beta particles and gamma rays. Instrument Development Laboratories, Chicago, Ill.

O-500 **Electric Speed Indicators.** 4-page 8½" × 11" bulletin pictures and describes indicators designed for industrial, marine and switchboard applications. They attach to a-c. or d-c. lines and have terminal screws, fuses and their own voltage regulators. Specifications, features and ordering information. Westberg Manufacturing Co., 6[illegible] Onarga Ave., Chicago 31, Ill.

O-501 **"Modern Precision."** 8-page 10½ × 15½" Vol. 7, No. 2 of this house organ covers articles on instrumentation connected with metals, rock and clay products, power, process industries, and research, teaching and testing. Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia 44, Pa.

O-502 **"C.E.C. Recordings"** 6-page 8½ × 11" Vol. 1, No. 3 of this house organ features several articles: "Consolidated Exhibit at Instrument Conference in Chicago September 8-12," "Gas Compan[illegible] Tests Prove New Use for Vacuum Leak Detector," and "Philip S. Fogg appointed to Atomic Post by Lilienthal." Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif.

O-503 **Precision Switch.** 2-page 8½" × 11" bulletin pictures and describes the application, operation, construction and specification of new unit. Friez Instrument Div., Bendix Aviation Corp., Baltimore 4, Md.

O-504 **Control Units.** 1-page 8½" × 11" sheet announces the "Xactline Capacitrol" with electronic control principle, instantaneous control action, direct-reading indicating scale and interchangeable unit construction. Claud S. Gordon Co., Chicago, Ill.

O-505 **Gravity Testers.** 2-page 8½" × 11" Catalog Section 91-B pictures and describes maker's line of specific gravity testers for determining the density of products, draw-offs and slops from distillation columns. Fischer & Porter Co., Hatboro, Pa.

O-506 **Boiler Water Level Controls.** 4-page 8½" × 11" Bulletin 147 illustrates and describes maker's line of boiler water level controls, methods of pump control, low-water fuel cut-off and low-water alarm. Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago 23, Ill.

O-507 **Thermostat.** 2-page 8½" × 11" bulletin describes and gives specifications of the "Scaico" thermostat characterized by small mass (1½ oz.) which enables it to rapidly absorb or give up heat, thus assuring control under wide load changes. Smith Control & Instrument Corp., 1329 Highland Ave., Needham 92, Mass.

O-508 **Volt-amp-wattmeter.** 2-page 8½" × 11" bulletin pictures and describes the new "Model 390" (3" × 5⅞" × 2½") for testing electrical appliances. Simpson Electric Co., 5200-18 W. Kinzie St., Chicago 44, Ill.

O-509 **Blending Valve.** 4-page 8½" × 11" bulletin describes maker's "Type 230" blending valve. Includes article: "Proportioning Valves Speed Blending of Gasoline, Eliminates Mixing Tanks at Pipe Line Terminal." Fisher Governor Co., Marshalltown, Iowa.

O-510 **Insulation Tester.** 2-page 7¾" × 10½" Bulletin 21-46 describes rectifier-operated tester, useful where a large number of tests are to be made at one time, and also where an individual test is continued for many minutes. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

O-511 **Meteorological Instruments.** 2-page 8½" × 11" revised Bulletin No. 6000 describes in detail maker's line of wind velocity and wind direction instruments: electronic and d-c. (wind powered) anemometers; high-capacity, moderate-capacity, and d-c. type wind direction instruments; the Graphic Recorder, and the Pilot Balloon Theodolite. W. & L. E. Gurley, Troy, N. Y.

O-512 **Time Delay Relay.** 2-page 8½" × 11" Bulletin No. 900B lists function application, construction, time ranges, price list and housing dimensions of the maker's product. R. W. Cramer Co., Inc., Centerbrook, Conn.

O-513 **Keying Relay.** 1-sheet 8½" × 11" Bulletin No. KR1 presents information, including engineering specifications for "Model RX-1074-F" keying relay. Signal Engineering & Mfg. Co., 154 W. 14th St., N. Y. 11, N. Y.

O-514 **Combustion Control.** 8½" × 11" folder pictures and describes "Model 111" electronic combustion control for reducing smoke to increase boiler-efficiency. Furst Electronics, 800 W. North Ave., Chicago 22, Ill.

O-515 **Deep-well Surveys.** 8½" × 11" 4-page bulletin gives information and a price list of the manufacturer's "Magnaflector" service. McCullough Tool Co., 5820 S. Alameda St., Los Angeles 11, Calif.

O-516 **Washability Machine.** 4-page 6" × 9" bulletin illustrates and presents data on the "Model 105" electrically-operated straight-line washability machine. Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.

O-517 **pH Testers.** 4-page 8" × 3½" folder illustrates and describes the "Hydrion" pH Test papers that cover the

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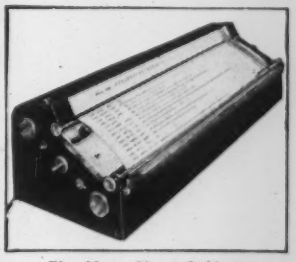

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